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Response of Recent Benthic Foraminiferal Assemblages to Contrasting Environments in Baffin Bay and the Northern Labrador Sea, Northwest Atlantic

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ABSTRACT. Modern deep-water benthic foraminiferal assemblages in Baffin Bay and the northern Labrador Sea, Western North Atlantic, were sampled from box cores and analyzed to determine assemblage composition. The two marine basins are separated by the shallow waters of Davis Strait. Assemblages of Baffin Bay contained only agglutinated foraminifera, whereas samples from the Labrador Sea contained both calcareous and agglutinated species, which resulted in significantly higher species richness. The absence of benthic calcareous taxa in Baffin Bay is attributed to cold, saline, CO_2-rich bottom waters related to the Baffin Bay Bottom Water and the Baffin Bay Atlantic Water. Modern foraminiferal assemblage distribution supports the model of increased organic flux under seasonal open-water conditions that feed a rich agglutinated assemblage, but lead to oxidation of organic matter and increased carbonate dissolution. Deep-water sediments contain ice-rafted coarse-grained components and biogenic elements such as sponge spicules that are heavily used by numerous agglutinated species for test construction. Robust, tubular suspension feeders occupy regions under the influence of bottom currents that deliver nutrients. Although disturbances of the sediment-water interface cannot be excluded with sampled box cores, small-scale patchiness can be confirmed by varying abundances of infaunal taxa. Absolute counts of specimens in subsamples vary significantly, whereas species evenness among subsamples is less variable. These findings call for caution when interpreting lateral faunal changes on the basis of small core samples.

Key words: benthic foraminifera, Baffin Bay, Labrador Sea, carbonate dissolution, faunal patchiness

RÉSUMÉ. Nous avons échantillonné des assemblages modernes de foraminifères benthiques d'eau profonde prélevés dans la baie de Baffin et le nord de la mer du Labrador, Atlantique du Nord-Ouest, à partir de carottes à boîte, puis nous les avons analysés afin d'en déterminer la composition. Les deux bassins marins sont séparés par les eaux peu profondes du détroit de Davis. Les assemblages de la baie de Baffin ne renfermaient que des foraminifères agglutinants, tandis que les échantillons de la mer du Labrador contenaient à la fois des espèces calcaires et des espèces agglutinantes, ce qui a donné lieu à une richesse d'espèces considérablement supérieure. L'absence de taxons calcaires benthiques dans la baie de Baffin s'explique par la présence d'eau de fond froide, saline et riche en CO_2 provenant de l'eau de fond de la baie de Baffin et de l'eau atlantique de la baie de Baffin. La répartition des assemblages foraminifères modernes cadre avec le modèle du flux organique accru moyennant des conditions saisonnières en eaux libres qui alimentent un riche assemblage agglutinant, mais qui se traduisent par l'oxydation de la matière organique et l'intensification de la dissolution du carbonate. Les sédiments en eau profonde contiennent des composantes glacielles à grains grossiers et des éléments biogènes tels que le spicule de spongiaire dont dépendent de nombreuses espèces agglutinantes pour la construction de tests. Des suspensivores robustes et tubulaires occupent les régions sous l'influence de courants de fond qui déposent des nutriments. Bien que la perturbation de l'interface sédiment-eau ne puisse pas être exclue à l'aide des carottes à boîte, une microrépartition à petite échelle peut être confirmée au moyen de l'abondance variable des taxons benthiques. Les dénombrements absolus de spécimens des sous-échantillons varient considérablement, tandis que l'homogénéité des espèces parmi les sous-échantillons est moins variable. Ces constatations font appel à la prudence quand vient le temps d'interpréter les changements fauniques latéraux en fonction de petites carottes.

Mots clés : foraminifère benthique, baie de Baffin, mer du Labrador, dissolution du carbonate, microrépartition faunique

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INTRODUCTION

Davis Strait separates Baffin Bay from the Labrador Sea, and its shallow depth contributes to deep-water circulation patterns that in turn result in contrasting ecological environments for deep-water biota. Modern deep-water benthic foraminiferal assemblages in Baffin Bay and the northern Labrador Sea in the Western North Atlantic are influenced by oceanographic circulation patterns, water mass distribution, and lithofacies and their geochemical processes. Sediment distribution is controlled by biogenic productivity, calcium carbonate dissolution, and sediment input from

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turbidites and ice rafting (Aksu and Piper, 1979; de Vernal et al., 1992). Distribution of recent diatom assemblages in Baffin Bay and Davis Strait was reported by Williams (1986). Zooplankton community structure in Davis Strait and the northern Labrador Sea was presented by Huntley et al. (1983). In the past, sediments and their foraminiferal faunas in these regions have been studied from cores to investigate Quaternary glacial and interglacial cycles, carbonate dissolution patterns, and lithofacies changes related to climate change (e.g., Baker and Friedman, 1973; Aksu and Piper, 1979; Aksu, 1983; Osterman and Nelson, 1989; de Vernal et al., 1992). These core studies do not provide details on the composition and distribution of Recent agglutinated foraminiferal assemblages that form the dominant faunal component in these bottom sediments, which are influenced by corrosive conditions at the sediment-water interface. Nor do such studies contribute to our understanding of small-scale faunal distribution patterns, although they could profit from information about such patterns derived from modern analogue studies that address the patchiness of the benthic habitat.

This survey is based on seven box cores that contrast the modern deep-water benthic foraminiferal faunas of two habitats that are vastly different, though in relatively close vicinity: the northern Labrador Sea and Baffin Bay. The former is influenced by North Atlantic Deep Water, whereas the latter is controlled by Baffin Bay Atlantic Water and Baffin Bay Bottom Water. Each box core is represented by at least five subsamples, and their foraminiferal species were counted separately in order to address faunal patchiness, a phenomenon that is difficult to consider appropriately in studies based on piston cores or wells. This study is therefore an important modern analogue.

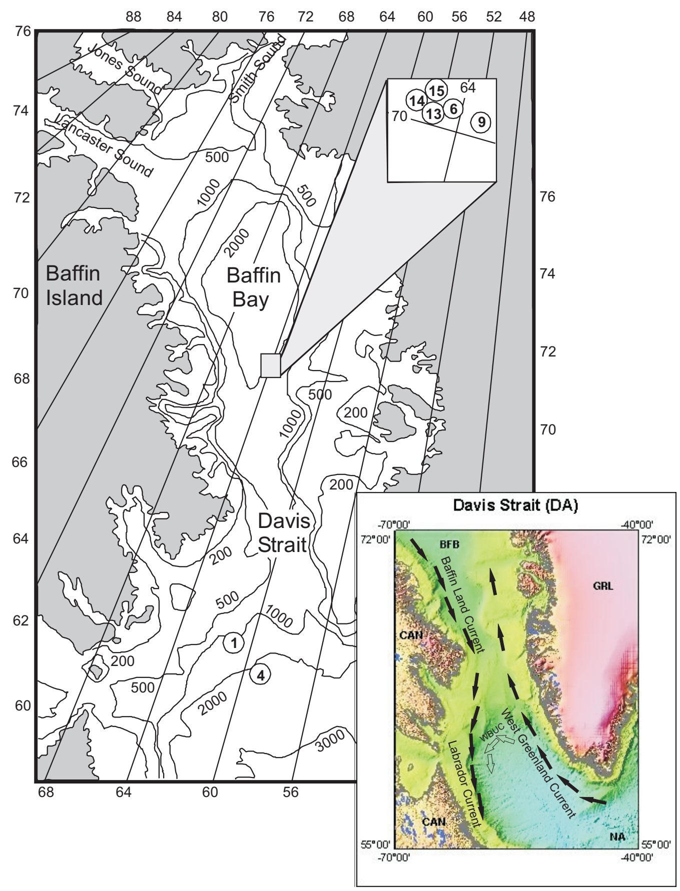


FIG. 1. Map of the northern Labrador Sea, Davis Strait, and Baffin Bay, showing locations of box-core samples. Insert from the USGS illustrates the sill of Davis Strait and a simplified pattern of the counterclockwise circulation of surface currents and the deep-water Western Boundary Undercurrent.

ENVIRONMENTAL SETTINGS OF BAFFIN BAY AND THE NORTHERN LABRADOR SEA

Baffin Bay (Fig. 1) is an elongate, semi-enclosed ocean basin between the Canadian Archipelago and Greenland. It is connected to the Atlantic Ocean through Davis Strait in the south and to the Arctic Ocean through the shallow (175 – 200 m) Lancaster, Jones, and Smith sounds (Baker and Friedman, 1973). Baffin Bay is on average 2400 m deep and is separated from the Labrador Sea by Davis Strait, a bathymetric high 700 m deep (Baker and Friedman, 1973). The shelf of Baffin Island is narrow and steep, less than 200 m deep, and cut by several deep trenches.

Sediments in Baffin Bay consist mainly of turbidites, debris flows, and diatom-rich muds (Baker and Friedman, 1973; Aksu and Piper, 1979). Abundant ice-rafted material is supplied by as many as 40 000 icebergs observed annually in the bay, which contribute a significant amount of sediment to the area (Aksu and Piper, 1979).

Three main water masses in Baffin Bay are recognized by their different salinity distributions and temperatures (Muench, 1971; Aksu, 1983). Baffin Bay Surface Water (BBSW) extends from the surface to 150–300 m depth and consists of a mixture of cold Arctic Water, which enters the bay through Lancaster, Jones, and Smith sounds, and warmer Atlantic water, which enters from Davis Strait (Muench, 1971; Aksu, 1983). The average temperature is between -1.8˚C and 1.8˚C, and salinity is low (31 – 34) but varies significantly over the extent of the bay because of extensive meltwater input during summers (Muench, 1971; Aksu, 1983). Below the BBSW is a layer of Baffin Bay Atlantic Water (BBAW) extending to 1300 m in depth. This water mass is also cold (0 – 2˚C) but more saline (34.3 – 34.5) than the BBSW (Aksu, 1983). BBAW is derived from the Atlantic Ocean through Davis Strait and cools through mixing with the BBSW (Aksu, 1983). This water mass is derived mainly from the Atlantic Water and North Atlantic Deep Water (NADW). The deep basin is occupied by the Baffin Bay Bottom Water (BBBW), which is the most uniform and the coldest (0˚C to 0.4˚C) of the three water masses, with a uniform salinity of 34.4 – 34.5. Below 1800 m, the dissolved oxygen content of the BBBW is low (3.2 – 3.5 ml/l), which may indicate that the circulation in the basin is restricted (Baker and Friedman, 1973; Tan and Strain, 1980). The BBBW originates from the Arctic Ocean and is restricted to Baffin Bay. Aksu (1983) suggested that the carbonate compensation depth (CCD) in Baffin Bay occurs between 600 and 900 m, and the foraminiferal lysocline may be as shallow as 100 – 300 m. Neither the CCD nor the lysocline seems to be associated with a particular water mass. The high alkalinity and high CO_2 concentration (> 2110 µmol/kg) are related to the cold surface-water masses with low dissolved oxygen (< 350 µmol/kg) (Jones and Levy, 1981). The surface circulation in Baffin Bay is generally counterclockwise (Fig. 1). The Baffin Land Current flows toward the south along the western coast of the bay, transporting cold water from the Arctic Ocean. The West Greenland Current enters from the Atlantic and flows around the southern tip of Greenland in a northerly direction (Williams, 1986).

Davis Strait, which forms a sill between Baffin Bay and the Labrador Sea (Fig. 1), is occupied by the Atlantic Water on the eastern side, which ranges from the surface to 1000 m depth, and by the Arctic Water on the western side. South of the strait, where two of our samples were located, the North Atlantic Deep Water (NADW) reaches approximately from 2000 to 4000 m depth. It is moved counterclockwise by the western boundary undercurrent (Fig. 1) with its high-velocity core between 2500 and 3000 m depth (Hillaire-Marcel and Bilodeau, 2000). Temperatures range between 2˚C and 4˚C, and salinity is 34.9 or higher (Warren, 1981; Dickson and Brown, 1994). A detailed description of the composition of the NADW can be found in Smethie et al. (2000) and Dickson and Brown (1994). The NADW is overlain by the Labrador Sea Water, which is characterized by temperatures varying between 3˚C and 3.5˚C and salinities between 34.8 and 34.9.

The northern Labrador Sea is represented by two box cores, No. 1 from the continental slope at 825 m and No. 4 from the continental rise at 2140 m. Baffin Bay was sampled at five locations (box cores 6, 9, 13, 14, and 15), which cover a depth range from 966 m on the continental slope to 2100 m on the continental rise (Table 1, Fig. 1).

METHODS

Samples were collected in Baffin Bay and the northern Labrador Sea during cruise 85-027 of the CSS *Hudson*, using a box corer with a 50 × 50 cm dimension. After each box core was retrieved and brought on deck, surface water was siphoned off through a 63 µm sieve to retain specimens that might have been disturbed and separated from the sediment. Each box core was subdivided with a partitioning frame into nine squares of equal size. Samples were taken by shaving off approximately the upper 3 cm of sediment within each square (~16 × 16 cm) and preserved in an ethanol-water solution. Wollenburg and Mackensen (1998), who studied living infaunal vs. epifaunal benthic foraminifera from the Arctic Ocean, found that the great majority of living benthic species occurred in the upper 2 cm of sediment. On the basis of those findings, we believe that our sampling method did not exclude significant infaunal components. The box cores preserved sediment at the sediment-water interface relatively undisturbed (Fig. 2), although some specimens were displaced, as seen in samples that contained the siphoned-off water. The sampling equipment used by Snider et al. (1984), which takes a subsample through an attached tube at the time the corer penetrates the seafloor, was not available. Bett et al. (1994), who describe the sampler bias in metazoan deep-sea meiobenthos studies by comparing box-core data with multiple corer data, demonstrated that a considerable faunal loss occurs with box corers because of the instrument's inability to preserve the sediment surface accumulations of phytodetritus. Epifaunal live foraminiferal assemblages are associated with the phytodetritus layer (Lambshead and Gooday, 1990), and consequently, some faunal loss (particularly of epifaunal taxa) and disturbance of the sediment surface layer cannot be excluded.

In the laboratory, samples were washed through a 63 µm sieve to remove the silt and clay fractions and stained with Rose Bengal to distinguish living from dead specimens at the time of collection. Samples were kept in an ethanol-water solution at all times. Samples were divided by using an Otto microsplitter for wet sediments. Wet subsamples were examined for foraminifera, and after preparing key slides for taxonomic identifications, we counted a minimum of 300 specimens in each subsample. Appendix 1 presents these specimen counts as relative abundance of a species within each subsample, total counts of specimens per species per box core, percentages of species per box core, and total counts of foraminifera. In box cores 1 and 4 from the northern Labrador Sea, planktic foraminifera were counted for completeness, but not included in percentage calculations; however, box cores from Baffin Bay did not yield planktic foraminifera. Statistical analysis was performed with the PAST software by Hammer et al. (2001). Species diversity is expressed as simple species richness and by the Fisher's alpha index as defined by the formula $S = \alpha \ln(1 + n/\alpha)$, where S is the number of taxa, n is the number of individuals, and α is the Fisher's alpha (Murray, 1991). Evenness was calculated as eH/S, where S is the number of taxa, and H is a number derived from the Shannon diversity index (Buzas and Gibson, 1969).

Tubular species such as *Argillotuba argillacea*, *Rhabdammina agglutissima*, and *Dendrophyra arborescens* are often found fragmented, but remain recognizable. Each fragment was counted as one individual, exaggerating their total numbers. Living populations are not discussed because thick-walled agglutinated species do not reveal their stained protoplasm body without being crushed. Other problems with the Rose Bengal method are discussed by Jorissen et al. (1995). In order to contrast modern benthic assemblages of the two sampled basins, we chose to report total numbers including counts of living and dead specimens. The authors are aware of the complexities that stem from taphonomic loss and the advantage of using only dead assemblages as outlined by Murray (2000). In this study, however, we have no core samples to address the downcore

Box core 1 – 825 m Labrador Sea

Box core 4 – 2140 m Labrador Sea

Box core 13 – 966 m Baffin Bay

Box core 15 – 1631 m Baffin Bay

Box core 6 – 2029 m Baffin Bay

Box core 14 – 1360 m Baffin Bay

FIG. 2. Photographs of sediment surfaces in box cores. **Northern Labrador Sea**: Box core 1 shows dense mat of sponge spicules. Box core 4 shows a dense patch of agglutinated foraminifera, including many tubular specimens. Note coarse-grained pebbles in sediment from ice-rafting. **Baffin Bay**: Box core 13 shows a mud-dominated sediment. Box core 15: Note the undisturbed tubular foraminifer in life position, casting a shadow. Box core 6 includes ice-rafted material. Box core 14 shows fine-grained tubular foraminifera and a large ice-rafted pebble.

preservation potentials of individual species. Original references of all identified taxa are provided in Appendix 2.

RESULTS

Sediment composition varies among samples, with variable amounts of coarse-grained ice-rafted debris and mud (Fig. 2). Meio- and macrofaunal communities are most extensive in box cores 1 and 4 from the northern Labrador Sea and 6 and 9 from Baffin Bay (see Table 1 for sample locations, depths, and sediment descriptions). Although siliceous sponge spicules and diatoms occur in all locations, sponges form a dense mat of spicules in box core 1 (Fig. 2), and diatoms become particularly abundant in box cores 6 and 9 from Baffin Bay. A total of 78 agglutinated, 82 calcareous, and 2 planktic foraminiferal species were identified and counted. Live specimens of most species were encountered in variable proportions. The two box cores from the Labrador Sea locations are the only samples containing calcareous benthic and planktic foraminifera and other calcareous organisms; the samples from Baffin Bay are entirely composed of agglutinated foraminifera lacking calcium carbonate. In the following discussion of species distribution, the entire box-core surface assemblage is taken into account. Faunal differences between subsamples within box cores are discussed separately.

Foraminiferal Species Distribution in the Northern Labrador Sea

Box core 1, located at 825 m on the continental slope in the northern Labrador Sea, contains the largest foraminiferal species richness, with 40 agglutinated species, 62 calcareous species, and two planktic species (*Neogloboquadrina pachyderma* and *Globigerina bulloides*). The calcareous species form 61% of the total number of specimens (not counting planktic specimens), the most common species being *Cibicidoides lobatulus* (14%), *Nonionella auricula* (11%), and *Epistominella pacifica* (9%) (Figs. 3, 4). The genus *Cribroelphidium* comprises 7%, with numerous species representing less than 1%. Calcareous foraminifera (benthic and planktic) show minor signs of abrasion or dissolution. The agglutinated fraction is dominated by *Dendrophrya arborescens* (5%) and *Earlandammina inconspicua* (3%). The abundant sponge spicules can be found in the tests of *Marsipella cylindrica* (Fig. 5, specimen 9). *Tolypammina vagans* attaches its test to spicules (Fig. 5, specimen 2). Planktic foraminifera were abundant (500 – 2300 specimens in 5% of any subsample).

Box core 4, located at 2140 m on the continental rise, contains 51 agglutinated species, 49 calcareous species, and one planktic taxon (*Neogloboquadrina pachyderma*, sinistrally coiled). This sample is dominated by agglutinated species, which make up 78% of the total number of specimens. Dominant taxa are *Hyperammina* spp. and *Rhabdammina* spp. (28%), *Astrorhiza crassatina* (15%), and *Globotrochamminopsis bellingshauseni* (7%) (Fig. 3). Although fragmentation might have artificially increased the numbers of tubular taxa, the abundance of these species is clearly visible on the box-core surface at this locality (Fig. 2). The sediment contains a small amount of sponge

TABLE 1. Visual descriptions of the sand-sized fraction of each box core.

Location	Sample Description (> 63 µm)
Box core 1, Labrador Sea 62°01′07″ N, 60°40′36″ W 825 m	• Few sand grains • Few pebbles (1–2 mm) • Abundant sponge spicules • Rare diatoms • Intact sponges, echinoderms (brittle star) • Common nematode and polychaete worms • Amphipod crustaceans • Common bivalves and ostracods • Very abundant planktic foraminifera • Abundant calcareous and agglutinated benthic foraminifera
Box core 4, Labrador Sea 62°04′65″ N, 58°57′16″ W 2140 m	• Common fine to coarse sand grains • Common pebbles (0.5–30 mm) • Few sponge spicules • Common diatoms, few radiolarians • Few nematodes • Rare polychaetes and bivalves • Rare amphipod crustaceans • Moderately abundant planktic foraminifera • Calcareous and agglutinated benthic foraminifera
Box core 6, Baffin Bay 70°29′37″ N, 64°41′06″ W 2029 m	• Mostly fine to coarse sand • Common pebbles (0.5–20 mm) • Common diatoms • Rare sponge spicules • Rare nematodes, polychaetes, and amphipods • No calcareous foraminifera or other calcareous material
Box core 9, Baffin Bay 70°33′70″ N, 63°11′28″ W 2100 m	• Mostly diatoms (ooze) • Few clastic grains • Common pebbles (0.5–20 mm) • Few sponge spicules • Few radiolarians • Rare nematodes, polychaetes, and amphipods • No calcareous foraminifera or other calcareous material
Box core 13, Baffin Bay 70°16′94″ N, 65°16′39″ W 966 m	• Fine to coarse sand • Few cohesive mud lumps • Rare pebbles • Rare diatoms • Rare sponge spicules • No calcareous foraminifera or other calcareous material
Box core 14, Baffin Bay 70°22′04″ N, 65°36′39″ W 1360 m	• Fine to medium sand • Few pebbles • Many cohesive mud lumps • Rare diatoms • No calcareous foraminifera or other calcareous material
Box core 15, Baffin Bay 70°25′47″ N, 65°02′56″ W 1631 m	• Fine to coarse sand • Few pebbles • Rare sponge spicules • Rare diatoms • No calcareous foraminifera or other calcareous material

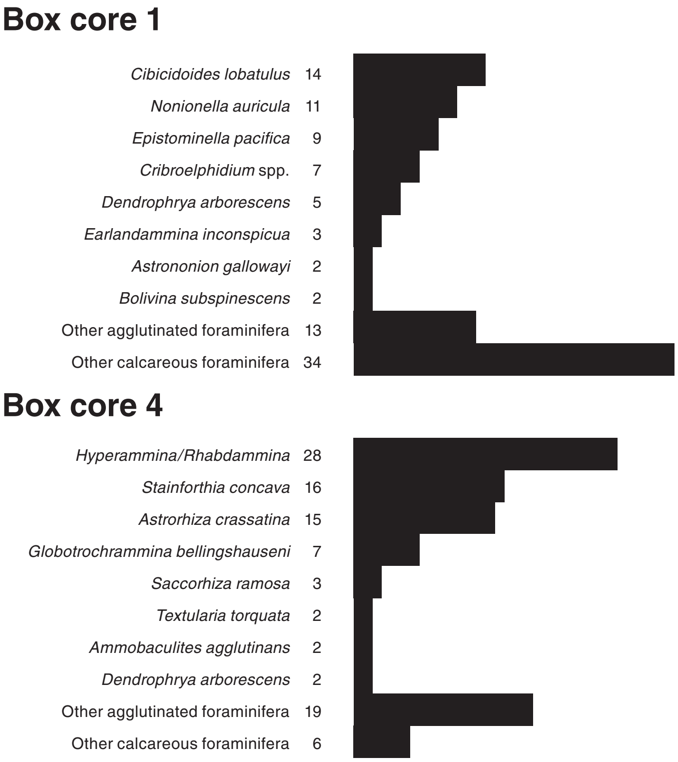


FIG. 3. Relative abundance of selected species in box cores 1 and 4, northern Labrador Sea.

spicules, which have been used by specimens of *Saccorhiza ramosa* for test construction (Fig. 5, specimen 6), a common phenomenon with this taxon (Schröder, 1986). Among calcareous species, *Stainforthia concava* is the most abundant (16%), whereas all other calcareous species make up less than 2% of the total population. The vast majority of calcareous species are well preserved, with the exception of specimens of *Buccella frigida* and *Epistominella* spp., two relatively fragile taxa that might have been transported downslope from shallower depth. Planktic foraminifera are common, but in numbers approximately one-fifth of those observed in box core 1.

Foraminiferal Species Distribution in Baffin Bay

Foraminiferal assemblages of all localities sampled in Baffin Bay are entirely of agglutinated nature, causing reduced species richness when compared with the northern Labrador Sea. Box core 9 at 2100 m (Figs. 6, 7, 8) is strongly dominated by *Adercotryma glomerata* (48%). Other common taxa include *Argillotuba argillacea* (17%), *Recurvoides contortus* (6%), *Rhabdammina agglutissima* (6%), and *Textularia wiesneri* (5%), among other less common ones. The sediment is rich in diatoms, with only minor sponge spicules.

Box core 6 at 2029 m contains 30 agglutinated species and is dominated by *Adercotryma glomerata* (32%), *Reophax guttifer* (13%), *Recurvoides contortus* (10%), *Astrorhiza crassatina* (8%), *Rhabdammina agglutissima* (8%), and *Textularia wiesneri* (7%) (Fig. 6). Sediments contain a significant amount of diatoms, but only rare sponge spicules (Table 1).

The most common species in box core 13 (966 m) are *Lagenammina laguncula* (20%), *Rhabdammina discreta* (14%), *Argillotuba argillacea* (11%), and *Reophax guttifer* (8%) (Fig. 6). Box core 14 (1360 m) is dominated by *Argillotuba argillacea* (15%), *Rhabdammina discreta* (15%), *Lagenammina laguncula* (10%), and *Rhizammina algaeformis* (9%) (Fig. 6). Box core 15 (1631 m) contains common, coarse-grained agglutinated species and is dominated by *Recurvoides contortus* (42%), *Reophax scorpiurus* (11%), and *Rhabdammina agglutissima* (11%) (Figs. 6, 7). Box cores 13 (966 m), 14 (1360 m), and 15 (1631 m) are similar in both sediment types and species richness. Box core 13 contains the largest amount of diatoms of the three samples, and box core 14 contains the largest amount of fine-grained sand, while core 15 contains abundant coarse-grained sand. This difference in sediment texture is reflected in faunal composition. A significant percentage of *Rhabdammina agglutissima* (11%), possessing a particularly coarse-grained test (Fig. 8, specimens 1a–d), is associated with the coarser substrate of box core 15.

Foraminiferal Patch Structure

Box cores were subsampled into nine squares, and five to eight of these were studied for foraminiferal content. Patchiness is most pronounced in box cores from Baffin Bay, where only agglutinated foraminifera are present. As mentioned under Methods, a certain degree of sediment-water interface and loss of phytodetritus cannot be excluded with our sampling procedure; therefore, only box core 6 from Baffin Bay was chosen to illustrate varying abundances of dominant species between subsamples (Fig. 9). Total numbers of all other subsamples can be found in Appendix 1. Infaunal species would have suffered fewer disturbances than epifaunal species during box-core retrieval. Certain robust tubular species, as suspension feeders anchored in the sediment, might have shifted less than strictly epifaunal species. Among the selected taxa in Figure 9, *Textularia* and *Reophax* might be regarded as infaunal, and *Rhabdammina* as a suspension feeder. *Adercotryma glomerata* is reported to prefer an epifaunal to shallow infaunal habitat in the Arctic Ocean (Wollenburg and Mackensen, 1998), and in laboratory experiments, *Adercotryma* preferred an epifaunal habitat (Heinz et al., 2002). *Adercotryma* shows a significant difference by varying between 15.84% and 42.29% in abundance among subsamples (Fig. 9). Its preferred habitat would suggest that counted numbers might reflect some disturbance of the in-situ community. In contrast, varying abundances of *Textularia* and *Reophax* with an infaunal habitat might confirm a certain patchiness, discounting disturbance during sampling. Varying abundances of tubular species might also result from different degrees of breakage. Total numbers per subsample in box core 6 vary significantly, from 1 to 4293 specimens (Fig. 9),

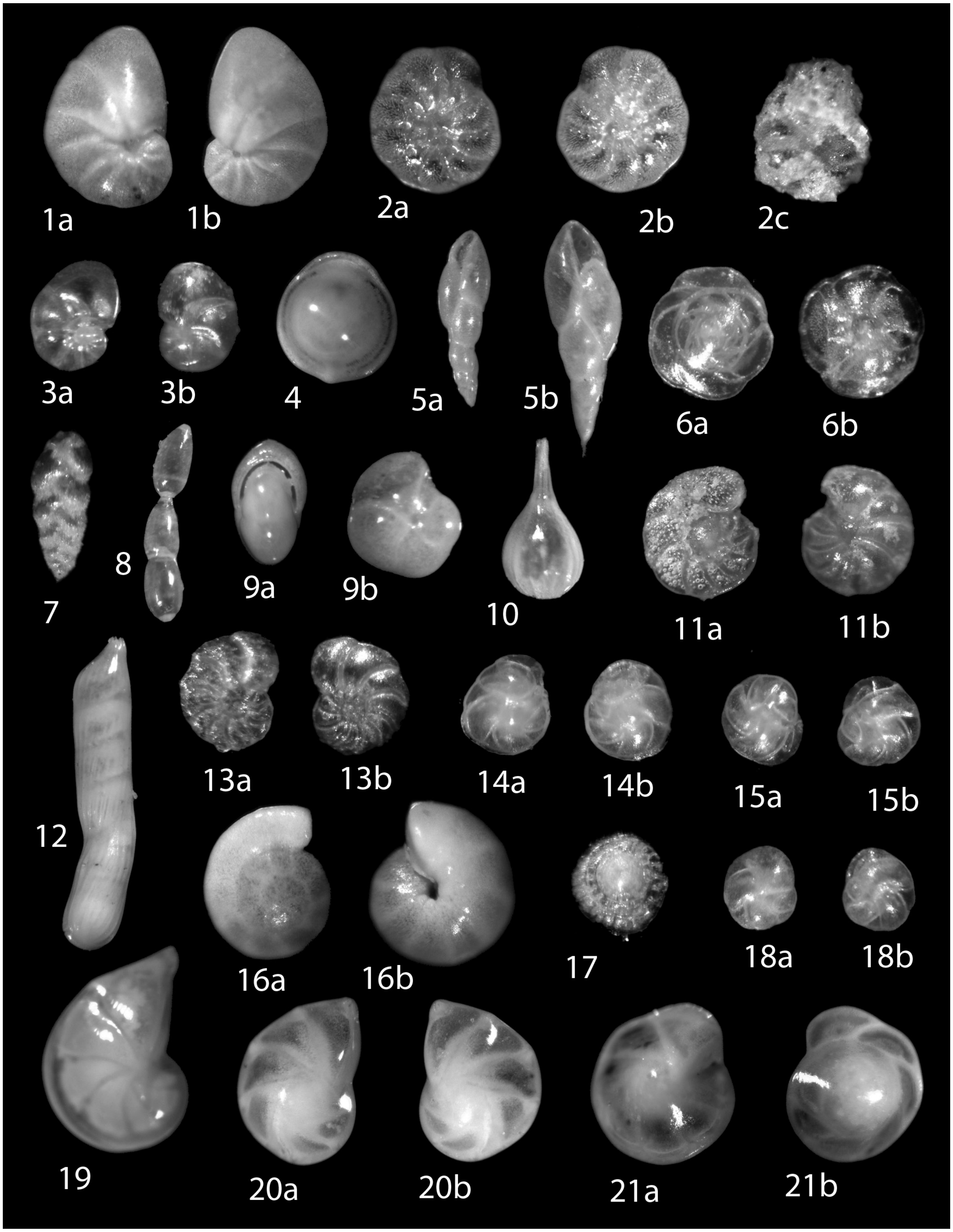


FIG. 4. Calcareous foraminifera from box cores 1 and 4, northern Labrador Sea. Box-core numbers are in parentheses, and size (µm) refers to longest axis of specimen: **1a**) *Nonionellina labradorica* (1) 450 µm; **1b**) *N. labradorica*, other side (1) 450 µm; **2a**) *Protelphidium orbiculare* (1) 420 µm; **2b**) *P. orbiculare*, other side (1) 420 µm; **2c**) *P. orbiculare* covered in sediment, alive when collected (1) 400 µm; **3a**) *Nonionella auricula* (1) 150 µm; **3b**) *N. auricula*, other side (1) 150 µm; **4**) *Fissurina marginata* (4) 250 µm; **5a**) *Stainforthia concava*, curved specimen (4) 500 µm; **5b**) *S. concava* (4) 510 µm; **6a**) *Buccella floriformis*, spiral side (1) 250 µm; **6b**) *B. floriformis*, umbilical side (1) 250 µm; **7**) *Bolivina subspinescens* (4) 320 µm; **8**) *Nodosaria calomorpha* (4) 550 µm; **9a**) *Pullenia quinqueloba*, aperture (4) 300 µm; **9b**) *P. quinqueloba*, side (4) 300 µm; **10**) *Lagena semilineata* (4) 400 µm; **11a**) *Cibicidoides lobatulus*, spiral side (1) 500 µm; **11b**) *C. lobatulus*, umbilical side (1) 500 µm; **12**) *Marginulinopsis linearis* (4) 2400 µm; **13a**) *Hanzawaia hamadaensis*, spiral side (1) 250 µm; **13b**) *H. hamadaensis*, umbilical side (1) 250 µm; **14a**) *Cassidulina laevigata* (1) 150 µm; **14b**) *C. laevigata*, other side (1) 150 µm; **15**) *Cassidulina neoteretis* (1) 200 µm; **16a**) *Gyroidina orbiculare*, spiral side (4) 420 µm; **16b**) *G. orbiculare*, umbilical side (4) 420 µm; **17**) *Patellina corrugata* (1) 75 µm; **18a**) *Cassidulina reniforme* (1) 120 µm; **18b**) *C. reniforme*, other side (1) 120 µm; **19**) *Astacolus reniformis* (4) 2200 µm; **20a**) *Lenticulina gibba* (4) 700 µm; **20b)** *L. gibba*, other side (4) 700 µm; **21a**) *Höglundina elegans*, umbilical side (4) 600 µm; **21b**) *H. elegans*, spiral side (4) 600 µm.

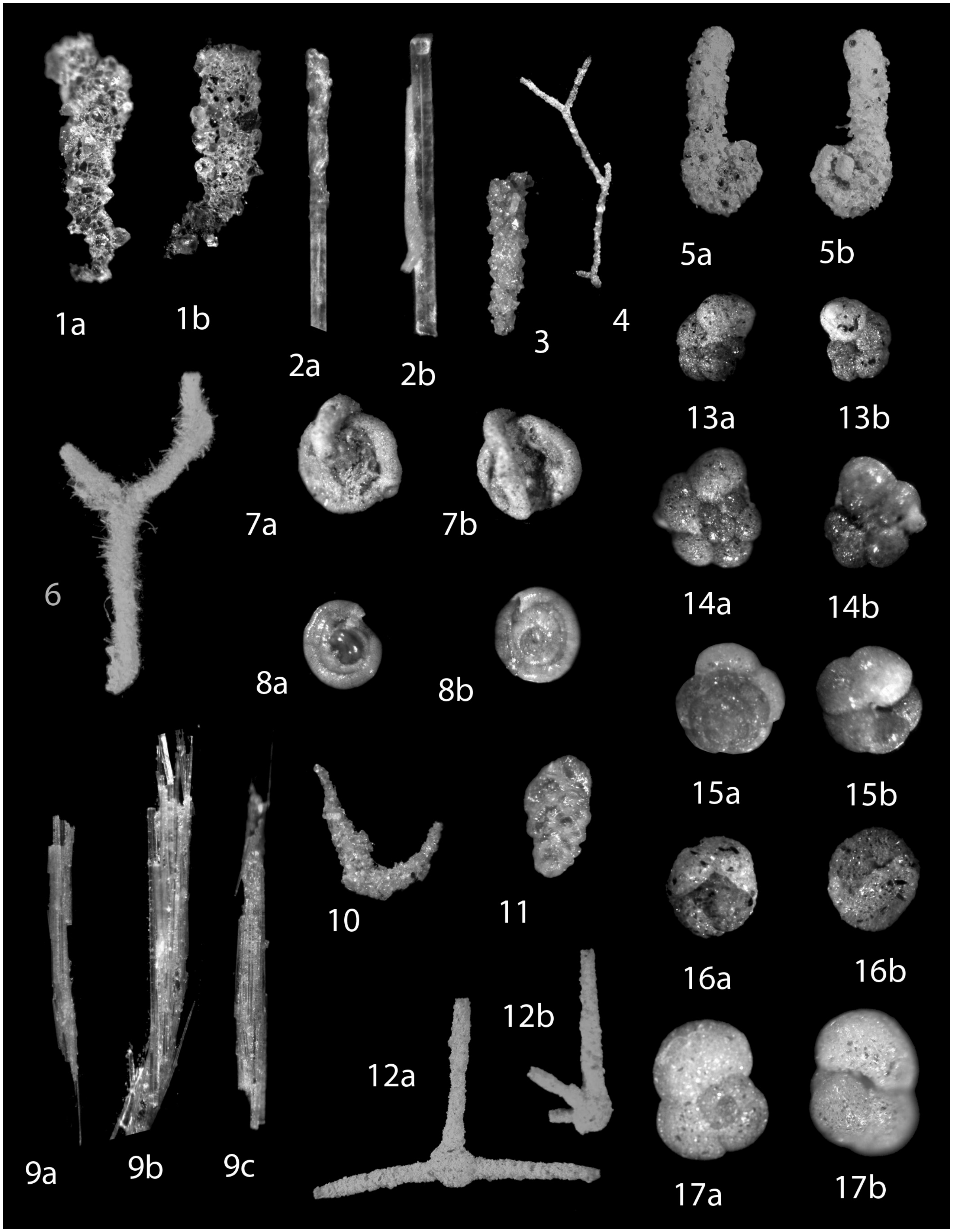


FIG. 5. Agglutinated foraminifera from box cores 1 and 4, northern Labrador Sea. Box-core numbers are in parentheses, and size (µm) refers to longest axis of specimen. **1a**) *Ammoscalaria tenuimargo* (4) 1450 µm; **1b**) *A. tenuimargo* (4) 2000 µm; **2a**) *Tolypammina vagans* on sponge spicule, curved (1) 850 µm; **2b**) *T. vagans* on sponge spicule, straight (1) 470 µm; **3**) *Jaculella acuta* (4) 2000 µm; **4**) *Dendrophyra arborescens* (4) 160 µm; **5a**) *Ammobaculites agglutinans* (4) 125 µm; **5b**) *A. agglutinans*, coarser side (4) 125 µm; **6**) *Saccorhiza ramosa* (4) 5700 µm; **7a**) *Glomospira gordialis* (1) 400 µm; **7b**) *G. gordialis*, other side (1) 400 µm; **8a**) *Repmanina charoides* (4) 300 µm; **8b**) *R. charoides*, other side (4) 300 µm; **9a**) *Marsipella cylindrica* (1) 1500 µm; **9b**) *M. cylindrica* (1) 3000 µm; **9c**) *M. cylindrica* (1) 2000 µm; **10**) *Marsipella elongata* (4) 1000 µm; **11**) *Textularia torquata* (4) 240 µm; **12a**) *Rhabdammina abyssorum* (4) 5800 µm; **12**b) *R. abyssorum* (4) 3100 µm; **13a**) *Pseudotrochammina echolsi*, dorsal (4) 600 µm; **13b**) *P. echolsi*, ventral (4) 600 µm; **14a**) *Deuterammina grahami*, dorsal (1) 400 µm; **14b**) *D. grahami*, ventral (1) 400 µm; **15a**) *Paratrochammina earlandi*, dorsal (1) 300 µm; **15b**) *P. earlandi*, ventral (1) 300 µm; **16a**) *Deuterammina goughensis*, dorsal (1) 500 µm; **16b**) *D. goughensis*, ventral (1) 500 µm; **17a**) *Globotrochamminopsis bellingshauseni*, dorsal (1) 550 µm; **17b**) *G. bellingshauseni*, ventral (1) 550 µm.

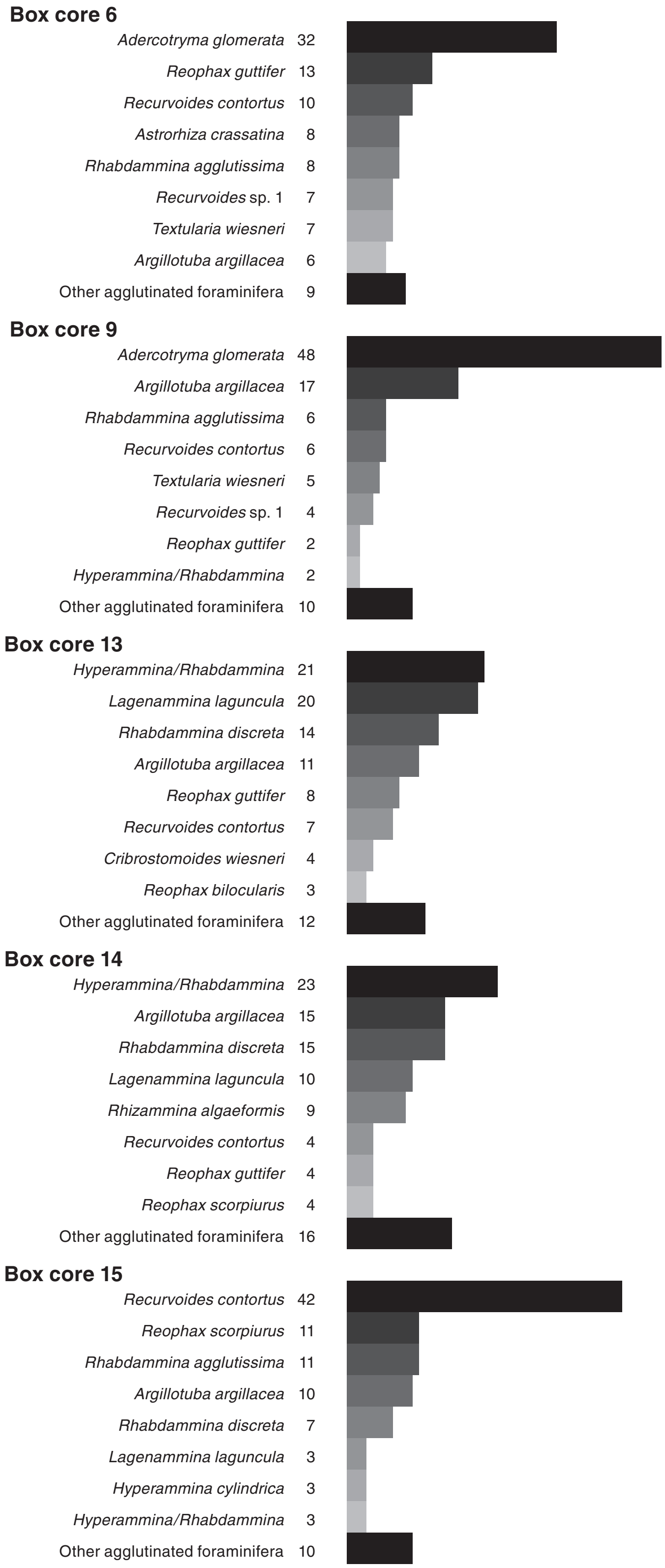


FIG. 6. Relative abundance of selected species in five box cores from Baffin Bay.

showcasing an extreme variability in foraminiferal abundance on a small scale. Species richness, diversity as measured with the Fisher's alpha index, and evenness within subsamples are also variable in all box cores (Table 2). Assemblages of the northern Labrador Sea are marked by high diversities and relatively low evenness, whereas Baffin Bay assemblages show low, but variable species diversity with a higher degree of evenness. Within box core 6, the total number of species per subsample varies from 14 to 24, and the Fisher's alpha index ranges from 2.75 to 4.25. However, subsample 6BB is not included in that calculation or listed in Table 2 and Figure 9 (relative abundance charts) because only one specimen was recovered.

DISCUSSION

Comparison of foraminiferal assemblages in surface sediments of Baffin Bay and the northern Labrador Sea indicates different ecological environments, particularly for calcareous species. The most striking commonality to all Baffin Bay assemblages covering a depth range of 900 to 2100 m is the lack of calcareous foraminifera. Several studies (Stehman, 1972; Stehman and Gregory, 1973) reported planktic foraminifera occurring abundantly in surface waters in Baffin Bay. Therefore, the absence of calcareous foraminifera in bottom sediments has to be a function of dissolution and corrosive bottom waters. The lack of calcareous fauna in this area of Baffin Bay agrees well with the shallow CCD between 600 and 900 m in this region, as suggested by Aksu (1983), who found that the carbonate content of sediment samples decreased rapidly below 300 m in depth. Scott and Vilks (1991) reported similar results from the Yermak Plateau in the Arctic Ocean and proposed that the absence of calcareous species from some parts of the Arctic shelf is due to the presence of corrosive water that inhibits secretion of calcareous tests, as well as removing any calcium carbonate present in the water column before it can accumulate in sediments. The absence of calcareous foraminifera on the Yermak Plateau is unusual because most of the Arctic shelf is characterized by mixed faunas that contain both calcareous and agglutinated species (Phleger, 1952; Loeblich and Tappan, 1953; Vilks, 1969; Lagoe, 1977; Wollenburg, 1992). Other areas in the Arctic where carbonate dissolution is an important factor are the Laptev Sea (Wollenburg and Kuhnt, 2000), the Fram Basin (Scott and Vilks, 1991), and areas of the western Canadian Archipelago (Vilks, 1989). Wollenburg and Kuhnt (2000) stated that carbonate dissolution in the Arctic Ocean increases with decreasing water depth and increasing duration of ice retreat, whereas calcareous faunas under perennial ice cover remain well preserved. Rich calcareous foraminiferal assemblages under perennial sea ice in the Arctic Ocean were also reported by Schröder-Adams et al. (1990). In polar regions, calcium carbonate dissolution is enhanced by cold, saline, dense bottom water production in areas of sea ice. In these oxygenated waters, decaying organic matter on the sea floor causes increased CO_2 concentrations at the sediment-water interface, which in turn cause dissolution of calcium carbonate (e.g., Steinsund and Hald, 1994).

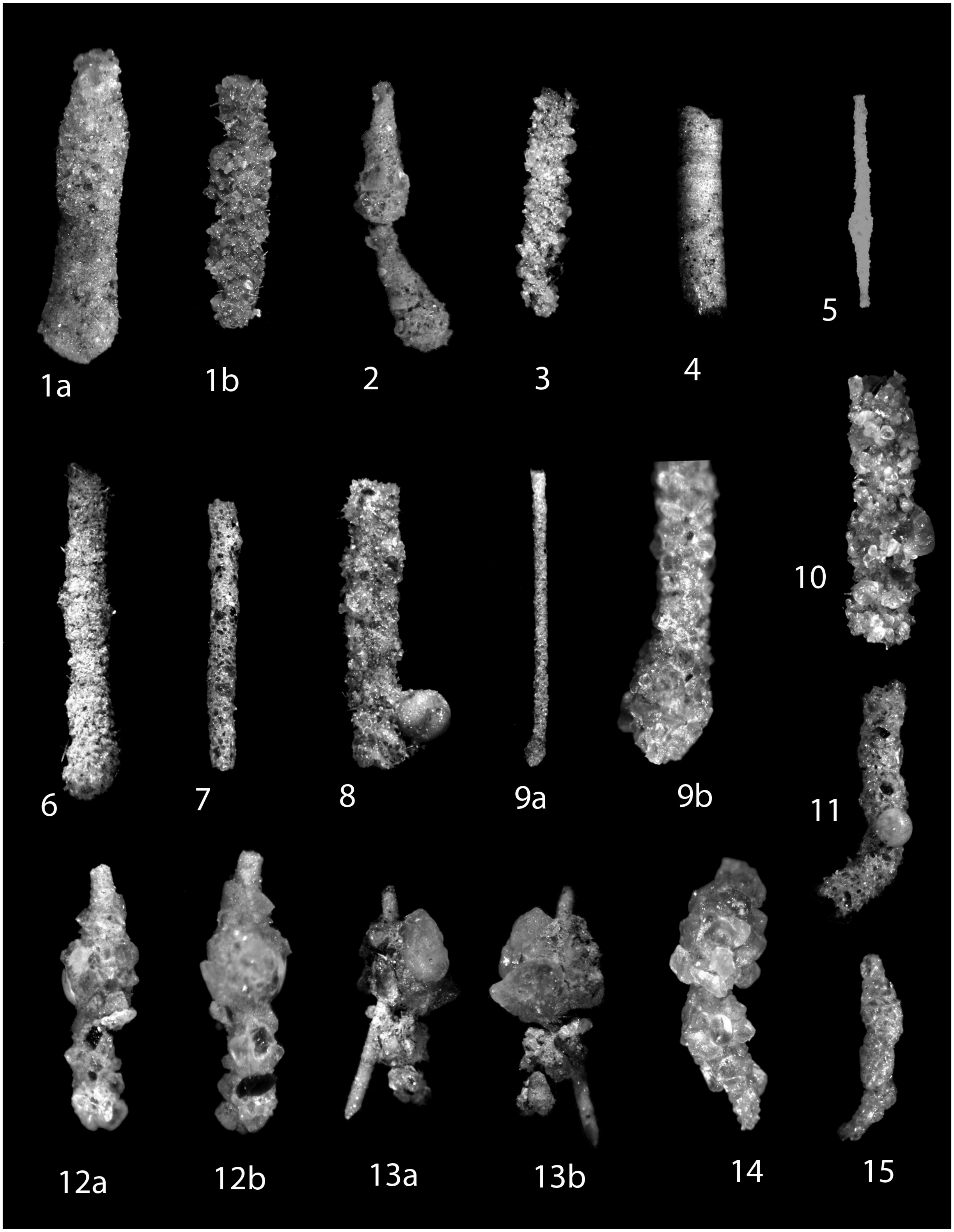


FIG. 7. Agglutinated species representing all box cores. Box-core numbers are in parentheses, and size (μm) refers to longest axis of specimen. **1a**) *Astrorhiza crassatina* (4) 6200 μm; **1b**) *A. crassatina* (6) 4500 μm; **2**) *Aschemonella scabra* (6) 1950 μm; **3**) *Rhizammina algaeformis* (4) 1400 μm; **4**) *Rhizammina indivisa* (6) 1200 μm; **5**) *Rhabdammina linearis* (4) 4300 μm; **6**) *Hyperammina* sp. (13) 4700 μm; **7**) *Hyperammina* sp. (9) 1800 μm; **8**) *Hyperammina/Rhabdammina* fragment with attached *Recurvoides contortus* (14) 3500 μm; **9a**) *Hyperammina elongata* (4) 4100 μm; **9b**) *H. elongata*, close up of proloculus (4) 500 μm; **10**) *Hyperammina* or *Rhabdammina* fragment (15) 3000 μm; **11**) *Subreophax aduncus* with attached diatom (14) 1100 μm; **12a**) *Reophax scorpiurus* (6) 1100 μm; **12b**) *R. scorpiurus*, other side (6) 1100 μm; **13b**) *Reophax scorpiurus* (14) 2800 μm; **13a**) *R. scorpiurus*, other side (14) 2800 μm; **14**) *Reophax scorpiurus* (15) 2200 μm; **15**) *Reophax scorpiurus* (4) 750 μm.

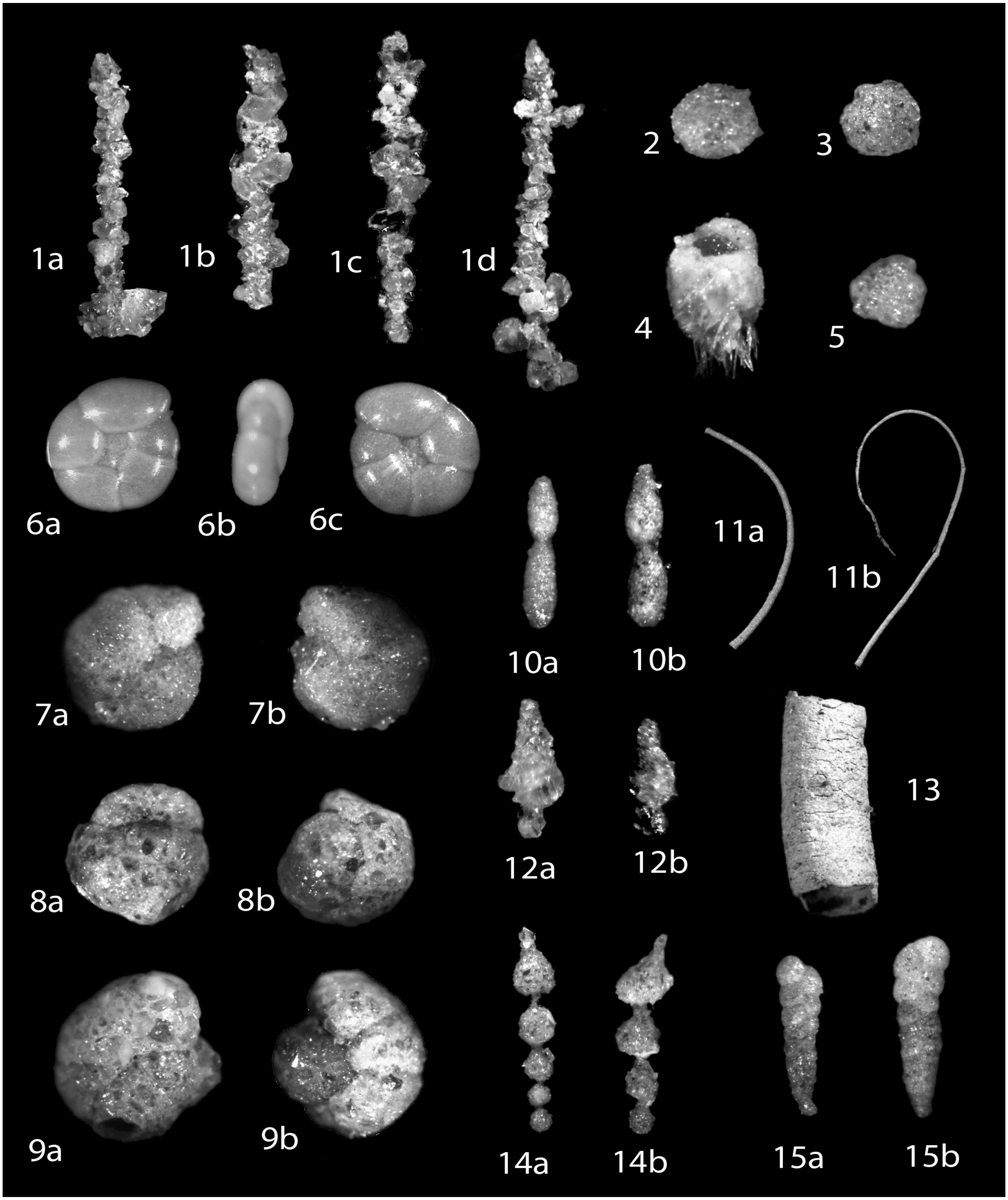
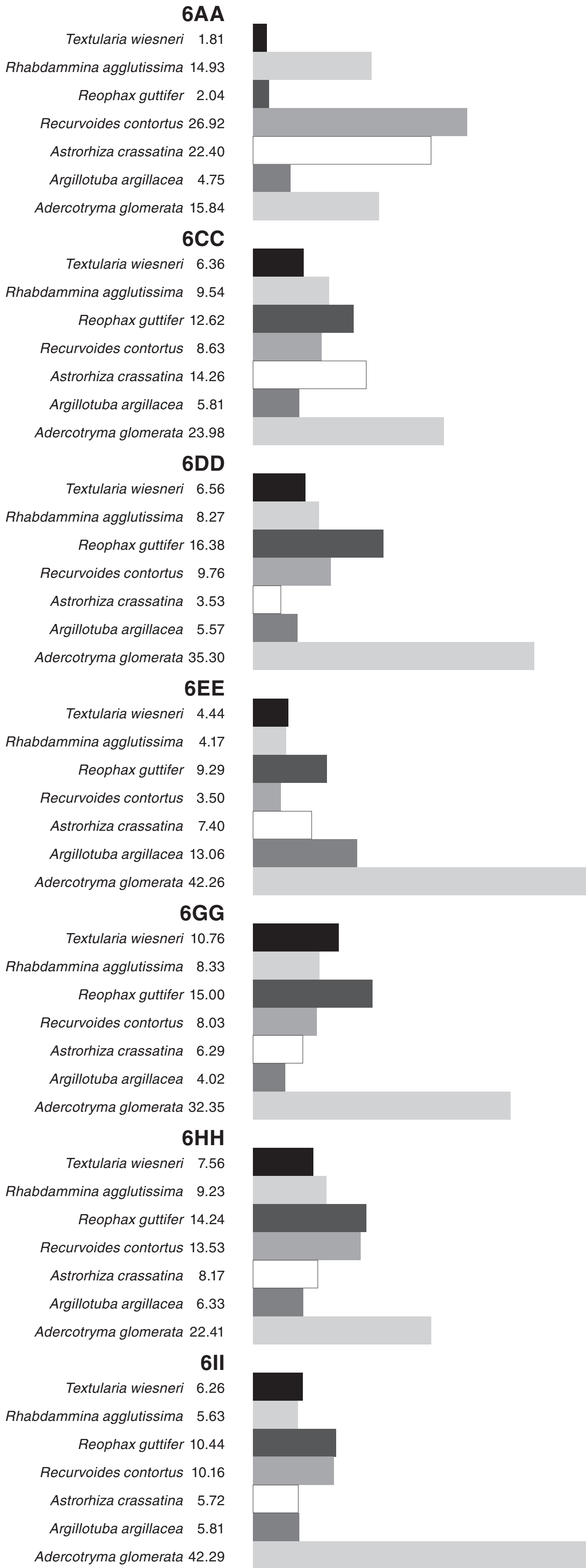


FIG. 8. Agglutinated species representing all box cores that are selective in agglutination. Box-core numbers are in parentheses, and size (µm) refers to longest axis of specimen. **1a**) *Rhabdammina agglutissima* (15) 2200 µm; **1b**) *R. agglutissima* (9) 2000 µm; **1c**) *R. agglutissima* (6) 3100 µm; **1d**) *R. agglutissima* (6) 7200 µm; **2**) *Thurammina papillata* (6) 200 µm; **3**) *Thurammina papyracea* (9) 300 µm; **4**) *Pelosina bicaudata* (6) 600 µm; **5**) *Adercotryma glomerata* (6) 150 µm; **6a**) *Cribrostomoides wiesneri* (4) 280 µm; **6b**) *C. wiesneri*, aperture (4) 280 µm; **6c**) *C. wiesneri*, other side (4) 280 µm; **7a**) *Recurvoides contortus*, curved side (13) 650 µm; **7b**) *R. contortus*, other side (13) 650 µm; **8a**) *Recurvoides contortus*, curved side (15) 800 µm; **8b**) *R. contortus*, other side (15) 800 µm; **9a**) *Recurvoides contortus*, curved side (6) 680 µm; **9b**) *R. contortus*, other side (6) 680 µm; **10a**) *Reophax ovicula* (6) 300 µm; **10b**) *R. ovicula* (9) 350 µm; **11a**) *Argillotuba argillacea* (6) 2600 µm; **11b**) *A. argillacea* (9) 5000 µm; **12a**) *Reophax bilocularis* (6) 300 µm; **12b**) *R. bilocularis* (9) 270 µm; **13**) *Pelosina cylindrica* (13) 2400 µm; **14a**) *Reophax guttifer* (6) 800 µm; **14b**) *R. guttifer* (9) 550 µm; **15a**) *Textularia wiesneri* (6) 380 µm; **15b**) *T. wiesneri* (9) 500 µm.



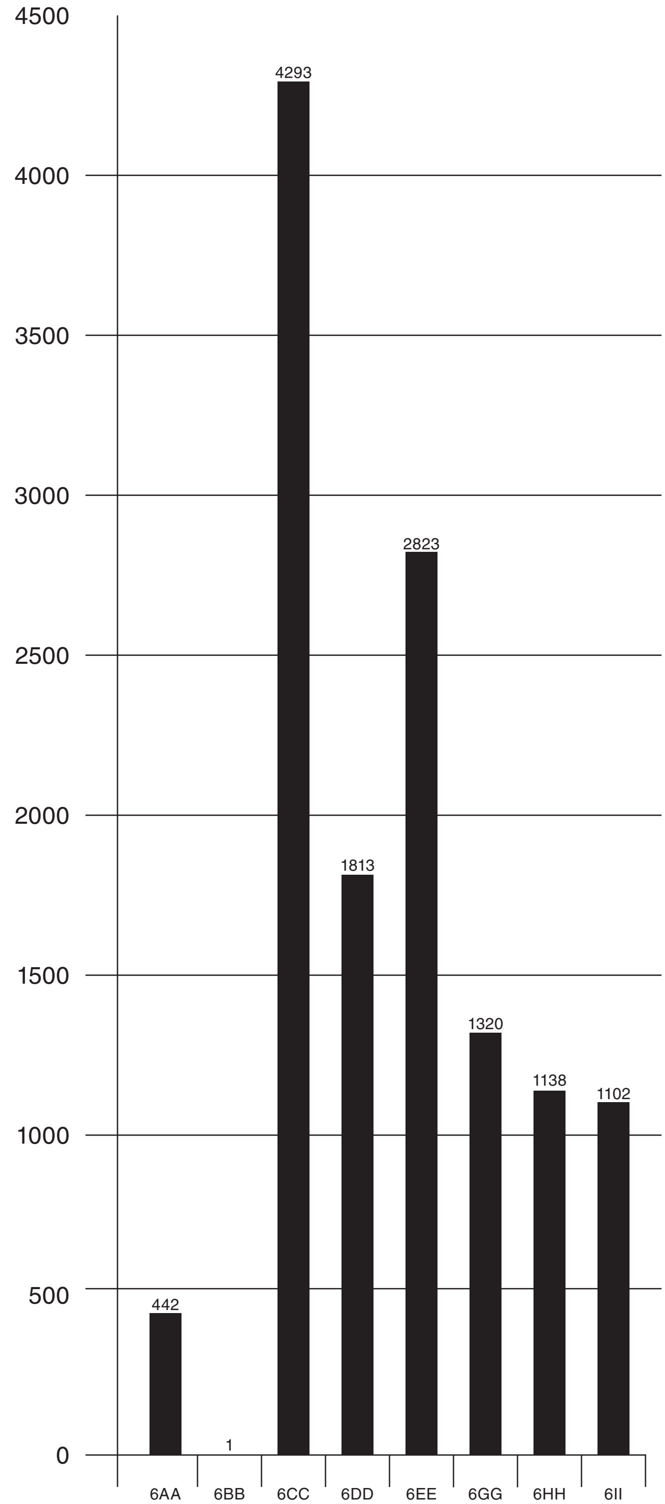


FIG. 9. Absolute abundance of agglutinated species within seven subsamples of box core 6 demonstrates patchy foraminiferal distribution in Baffin Bay. Subsample 6BB contained only one specimen and is included in the graph comparing absolute numbers in each subsample.

The water mass distribution in Baffin Bay (Muench, 1971) suggests that the CCD is not entirely associated with the extent of the BBBW where dissolution occurs in areas shallower than the recorded depths of the BBBW. Aksu

(1983) suggested that water of low temperature and high CO_2 content is the primary control on carbonate dissolution and accounts for the very shallow CCD in Baffin Bay. Since dissolution occurs at shallow and deep levels in Baffin Bay, it can be concluded that the presence of both BBAW and BBBW (both of which have low temperatures) contributes significantly to the dissolution of carbonate material. The absence of significant calcareous fauna in the sediments of Baffin Bay at depths between 100 and 850 m has also been documented by Schröder-Adams et al. (1990), who found that areas with seasonal ice cover and a large meltwater input during the summer have dominantly agglutinated assemblages. Scott and Vilks (1991) further state that it is the absence of permanent ice cover that permits the formation of the low-salinity, corrosive Arctic surface water. The Quaternary record, as seen in sediment cores from Baffin Bay, shows a cyclic pattern in carbonate preservation and dissolution that coincides with glacial and interglacial periods, dissolution of carbonate being more pronounced during interglacial stages (Aksu, 1983). Core studies by de Vernal et al. (1992) confirmed the Baffin Bay pattern of this study in Davis Strait. There, the use of organic foraminiferal linings vs. shell ratios demonstrated increasing carbonate dissolution during interglacial times, which are associated with cold, low-salinity surface waters; cold and poorly oxygenated deep waters; and high carbon flux. In contrast, glacial intervals are characterized by perennial sea ice restricting CO_2 exchange, low organic-matter flux resulting from low surface productivity, and increased northward flow of warm bottom waters.

In Baffin Bay, box cores 6 and 9 represent the two deepest localities (Table 1) and are dominated by *Adercotryma glomerata* (Fig. 6), a common species in both the North Atlantic and Arctic oceans (e.g., Schröder, 1986; Hunt and Corliss, 1993). The high numbers of this species are associated with the cold BBBW at this depth. This species moves into shallower water along the continental margin of Nova Scotia, where its preference for cold-water masses is associated with the cold Labrador Current (Williamson et al., 1984). Box cores 13, 14, and 15 differ from their deeper counterparts in being dominated by suspension feeders of *Hyperammina* and *Rhabdammina*, and by *Recurvoides contortus*, a species that is reported from a wide depth range. These localities are occupied more or less by the BBAW.

In the northern Labrador Sea, agglutinated foraminifera dominate the location on the continental rise compared to the continental slope (Fig. 3). This pattern agrees well with the observation by Aksu (1983) that carbonate dissolution also occurred in Davis Strait as depth increased, albeit to a smaller degree than in Baffin Bay. BBBW is absent from the northern Labrador Sea because of the topographic ridge of Davis Strait, reaching 700 m, which separates the two basins. This ridge also forms a barrier to the BBBW, so that the northern Labrador Sea is primarily influenced by the NADW (Warren, 1981).

A striking difference between the two localities in the northern Labrador Sea is the dominance of several tubular suspension feeders such as *Hyperammina* and *Rhabdammina* in box core 4 compared to box core 1. Suspension feeders have shown a preference for deep-water marine habitats where bottom currents deliver food sources (Linke and Lutze, 1993). At the location of box core 4, it is the western boundary undercurrent moving NADW in a counterclockwise direction south of Davis Strait (Fig. 1) that might be responsible for nutrient delivery. A similar faunal pattern occurs farther south along the continental slope and rise off Nova Scotia, where the same tubular taxa occur abundantly and are likewise associated with this deep-water current flowing southward (Schröder, 1986). In contrast, the fragile, branching, suspension-feeding taxon *Dendrophrya arborescens* is more common in box core 1 (Fig. 3), suggesting a position below the influence of the Labrador Current on substrates. Coarse-grained sediment, particularly in box core 4, might result partly from current winnowing and partly from ice-rafting.

Box core 1 is marked by a dense mat of siliceous sponge spicules (Fig. 2). Schröder-Adams et al. (1990) documented rich calcareous assemblages that occur in association with siliceous sponge communities in the Axel Heiberg Shelf region, which at the time of sampling was a perennially ice-covered area of shallow water (samples taken between 100 and 300 m). That fauna is similar to the foraminiferal assemblage and sponge community recovered from box core 1 in the northern Labrador Sea, which represents a deeper location with only intermittent ice cover. This environment shows a good example of the occurrence of selective agglutinated species, specifically *Marsipella cylindrica* (Fig. 5). This species prefers sponge spicules to build its test; therefore, as indicated by sampling of the other box cores, it is absent from areas where sponge spicules are lacking or present only in small numbers. Other selective species are illustrated in Figure 8. Box cores 6 and 9 differ from other box cores in the high content of diatoms in the sediment as the pelagic component increases in the deepest water localities. The reduced content of sand-sized clastic grains at these localities is reflected in the types of foraminifera found there. These box cores contain only a few specimens of *Hyperammina*, *Rhabdammina*, and *Recurvoides*, while finely agglutinated forms like *Adercotryma glomerata* and *Argillotuba argillacea* are the dominant species (Figs. 6, 8). The only common coarsely agglutinated species in both cores is *Rhabdammina agglutissima* (8% in core 6, 6% in core 9), indicating that this species may be the only one selectively using larger grains to build tests. It is important to note that there is no difference in the appearance of *R. agglutissima* tests between all seven cores, showing the availability in all samples (Fig. 8:1a–d) of the ice-rafted coarse grains that this species prefers for test construction. The main species found in this study that are non-selective with respect to test grains, including *Hyperammina* spp., *Rhabdammina* spp., and *Reophax scorpiurus*, are illustrated in Figure 7. These species are found over a large bathymetric range.

The abrasion and dissolution observed on some calcareous species (notably *Buccella frigida* and *Epistominella* spp.) in box core 4 may indicate that these specimens were transported downslope. In contrast, specimens of the same species found in box core 1 (a shallower location) showed no such abrasion or dissolution. This finding agrees with the concept that turbidites and debris flows are a major aspect of sediment transport along the continental slope into the deeper parts of Davis Strait and the Labrador Sea (Aksu and Piper, 1979). These processes of downslope transport, combined with ice-rafting, account for the coarse sediment and pebbles found in the deeper areas of the basin.

Patchy distribution of benthic foraminifera is a widely recognized phenomenon (e.g., Boltovskoy and Wright, 1976; Hunt and Corliss, 1993; Jorissen et al., 1995; Jannink et al., 1998; Fontanier et al., 2003). Patchy distribution has been found to vary both temporally and spatially. Bernstein and Meador (1979) showed that the patch structure in benthic foraminiferal communities persists through time (at least through several generations, as seen in positive correlations between living and dead specimens) and suggested that this persistence is a result of both active habitat selection by benthic species and reproductive patterns within the community. Jannink et al. (1998) found that for most species, there was no significant difference between the distribution of smaller (63–150 µm) and larger (> 150 µm) specimens, indicating that there was no change in microhabitat preference during their life cycles.

Studies of bathyal and sublittoral sites indicate that foraminiferal communities show seasonal (as well as shorter time-scale) changes resulting from the level of primary production (Gooday, 1993; Thomas and Gooday, 1996; Schmiedl et al., 2000; Fontanier et al., 2003) and organic carbon flux (Wollenburg and Kuhnt, 2000). These changes occur as increases or decreases in both total foraminiferal numbers and species diversity. Figure 9, which depicts small-scale distribution changes in box core 6, certainly confirms significant variation in total foraminiferal numbers and diversity measurements (Table 2). Opportunistic species (such as *Epistominella exigua*) show the greatest increase in numbers during such input events (Gooday, 1996). Such patterns have been used in the geologic record to reconstruct organic matter fluxes in oceans (Smart et al., 1994; Thomas et al., 1995). The amount of phytodetritus present on the seafloor also varies spatially as a result of primary production, currents, microtopography, and bioturbation (Rice and Lambshead, 1994; Rice et al., 1994), and this distribution will be mirrored by foraminifera that take advantage of phytodetritus as a food source. This relationship is most clearly seen in epifaunal and shallow infaunal species (Gooday, 1996). Our strategy of sampling only the upper 3 cm of sediment means that species observed in this study are mainly epifaunal and shallow infaunal, although we cannot exclude the possibility that bioturbation also added deep-infaunal species. Gooday's observation, however, accords with our finding that the epifaunal or shallow infaunal taxon *Adercotryma glomerata* shows the largest variation in abundance, as seen within box core 6 (Fig. 9). Vertical distribution of foraminifera in surface sediment was not addressed in this study; however, Gooday (1986) reports that the majority of deep-sea foraminifera (NE Atlantic) can be found on the sediment surface or in the top 2.5 cm of sediment, although some living specimens are found as deep as 15 cm. Hunt and Corliss (1993) report similar (up to 13 cm depth) vertical distributions for shallower areas on the Arctic shelf. Fontanier et al. (2003) report that the distribution of benthic foraminifera shows distinct patchiness that varies with time and can be correlated to phytoplankton blooms.

Results of extreme patchy distribution of specimen numbers and species (Fig. 9, Table 2, Appendix 1) highlight the problems inherent in working with sediment cores that represent only a small surface area. Much smaller faunal changes than the ones observed here between subsamples

TABLE 2. Diversity indices (species richness, evenness, and Fisher's alpha index) of all subsamples in box cores.

	Subsample	Species richness	Evenness	Fisher's alpha index
Box core 1:	1AA	65	0.3818	14.53
	1CC	70	0.332	17.13
	1EE	68	0.3551	17.33
	1GG	63	0.3862	17.04
	1II	54	0.4514	15.61
Box core 4:	4AA	50	0.2327	11.56
	4BB	58	0.2784	12.03
	4DD	52	0.2475	10.58
	4EE	56	0.2505	11.68
	4FF	56	0.2374	11.25
Box core 6:	6AA	14	0.4813	2.75
	6CC	20	0.5143	3.47
	6DD	19	0.4158	2.96
	6EE	22	0.3689	4.25
	6GG	24	0.3802	4.16
	6HH	23	0.4436	4.08
	6II	21	0.3564	3.68
Box core 9:	9BB	12	0.6184	2.78
	9CC	15	0.2626	2.47
	9DD	22	0.2608	3.77
	9EE	13	0.2735	1.99
	9FF	9	0.8211	2.33
	9HH	11	0.3429	2.19
	9II	9	0.4979	1.89
Box core 13:	13AA	17	0.5011	3.11
	13CC	17	0.5011	3.11
	13DD	22	0.4282	4.74
	13EE	15	0.5449	2.59
	13FF	23	0.4205	4.53
	13GG	19	0.5033	3.98
	13II	22	0.4571	4.34
Box core 14:	14AA	17	0.513	3.52
	14BB	16	0.5034	3.05
	14CC	18	0.4581	3.56
	14DD	22	0.4642	4.56
	14EE	22	0.4524	4.54
	14GG	18	0.5641	3.55
	14II	24	0.4709	5.11
Box core 15:	15AA	15	0.3621	2.58
	15CC	19	0.2928	3.88
	15DD	15	0.4551	2.8
	15EE	12	0.5202	2.21
	15FF	17	0.437	3.51
	15GG	16	0.4409	3.19
	15II	23	0.4474	5.11

have been interpreted in horizontal and vertical dimensions within core studies as representing significant ecological change. This study demonstrates the complexity of such interpretations.

Another aspect of using agglutinated and calcareous foraminiferal assemblages in paleoecological studies is their sometimes poor preservation potential. This study has also shown that fragile tests (e.g., those of the genera *Dendrophrya*, *Rhizammina*, *Thurammina*) disintegrate when handled, dried out, or compacted, so it is very unlikely that they will be preserved in the fossil record, or even in unlithified but slightly compacted sediment. The importance of taphonomic processes in paleoecological studies is abundantly documented (e.g., Schröder, 1986; Murray and Alve, 1999). The geological record shows a strong bias toward hard-shelled forms (calcareous and agglutinated) even though the majority of species found in the deep ocean are soft-shelled agglutinated species (Gooday, 1996). When the low preservation potential of some species is considered together with the patchy distribution, it has to be concluded that a small sample in a sediment core will not resemble the biocoenosis.

CONCLUSIONS

Benthic foraminiferal assemblages in Baffin Bay and the northern Labrador Sea have high abundances and species richness. Deep-water assemblages in the sampled area of Baffin Bay are composed exclusively of agglutinated taxa, while the northern Labrador Sea contains calcareous as well as agglutinated foraminifera.

The absence of calcareous foraminifera in Baffin Bay is attributed to the combination of increased organic flux during ice-free seasons and the production of cold, oxygenated, saline bottom waters that sink, resulting in oxidation of organic matter that causes dissolution at the sediment-water interface. *Adercotryma glomerata*, an indicator for cold-water masses, dominates the deeper parts of Baffin Bay influenced by the Baffin Bay Bottom Water, and *Hyperammina* and *Rhabdammina* as suspension feeders, together with *Recurvoides contortus*, dominate where the Baffin Bay Atlantic Water flows.

Sediment composition and grain size in these deep-water areas reflect a high amount of ice-rafted material, which added a coarser grain size. In addition, box cores under the influence of the western boundary undercurrent are coarse in nature because of winnowing effects. These areas are dominated by coarse-grained, tubular suspension feeders that profit from the nutrients delivered through currents. Distribution of sediments, including biogenic components such as siliceous sponge spicules, is reflected to a certain degree in the tests of agglutinated taxa.

The study of subsamples within box cores demonstrates that epifaunal species, shallow infaunal species, and suspension feeders are patchily distributed with respect to simple species richness, diversity as measured by the Fisher's alpha index, and absolute abundance. However, given the nature of our sampling instrument, we cannot exclude the possible influence of surface disturbances when comparing strictly epifaunal species abundances within box-core subsamples. The biological patch structures of benthic foraminifera generate caution in interpreting paleoecological changes on the basis of small core samples.

Agglutinated species will often disintegrate as a result of taphonomic processes, which adds another challenge in paleoecological studies. For many deep-sea agglutinated species encountered in this study, preservation potential is low; therefore, a small sample within a sediment core may not reflect the biocoenosis of a certain time slice.

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APPENDIX 1: Foraminiferal data from two box cores from the northern Labrador Sea and five from Baffin Bay. The following parameters are listed: 1) percent of each subsample counted (second row); 2) relative abundance of each species within each subsample and relative abundance of each species within the box core taking all subsamples into account (last column); 3) total counts of all calcareous species (last row of calcareous section) and of all agglutinated species (last row of agglutinated section) per box core; and 4) total counts of all foraminifera per box core (second-last column). Specimens found in drained surface water of each box core are listed; however, since these specimens are not in place, they are not included in actual percentage calculations. Planktic foraminifera are not listed.

Box core 1	Surface 1	Surface 2	Surface 3	1AA	1CC	1EE	1GG	1II	Total counts	Relative % in all subsamples
% counted in subsample	5	5	100	5	5	5	5	5		
Calcareous species										
Astacolus reniformis	–	–	–	–	–	–	–	0.21	1	0.00
Astrononion gallowayi	1.32	1.62	–	2.50	2.92	1.27	1.58	0.41	105	2.01
Bolivina subspinescens	2.10	2.31	9.59	3.27	1.89	2.18	2.19	2.70	130	2.49
Buccella floriformis	5.45	7.34	–	6.42	15.06	5.36	8.40	13.69	485	9.28
Buccella frigida	4.36	1.62	–	2.50	0.63	–	2.68	3.32	85	1.63
Cassidulina laevigata	2.18	1.62	–	1.35	1.10	1.73	0.61	0.62	62	1.19
Cassidulina reniforme	0.39	0.43	–	0.26	0.79	0.55	0.24	0.21	23	0.44
Cassidulina neoteretis	–	0.94	–	0.83	0.63	0.27	0.73	0.62	33	0.63
Cibicides sp.	17.20	7.00	19.18	14.96	9.38	14.91	16.08	20.12	745	14.25
Cibicidoides lobatulus	0.78	–	–	1.28	1.18	2.27	0.85	0.62	70	1.34
Cibicidoides wuellerstorfi	–	0.17	–	0.32	0.32	1.36	0.85	–	31	0.59
Cribroelphidium bartletti	0.78	0.77	–	0.90	0.32	0.45	0.97	0.62	34	0.65
Cribroelphidium clavatum	0.62	0.34	–	0.71	0.32	0.55	0.97	1.45	36	0.69
Cribroelphidium excavatum	0.70	0.34	0.68	0.83	0.32	0.55	0.85	2.70	43	0.82
Cribroelphidium incertum	0.31	0.26	–	0.96	0.39	0.36	0.12	1.04	30	0.57
Cribroelphidium subarcticum	–	0.85	–	–	–	0.82	0.85	1.24	22	0.42
Cribroelphidium spp.	2.33	2.22	2.05	2.50	1.74	2.00	3.41	7.47	147	2.81
Epistominella takayanagii	0.08	–	–	–	–	0.09	–	–	1	0.02
Eponides frigidus	–	–	14.38	–	–	–	–	–		0.00
Favulina hexagona	0.39	0.51	–	–	0.08	0.18	0.12	0.21	5	0.10
Favulina melo	0.08	–	–	0.19	–	0.18	–	–	5	0.10
Fissurina bradyii	–	0.09	–	–	–	0.18	0.24	0.21	5	0.10
Fissurina fimbriata	–	–	–	0.06	0.16	–	–	0.21	4	0.08
Fissurina marginata	2.41	1.71	–	1.41	1.26	0.82	1.10	0.62	59	1.13
Fissurina orbignyana	–	–	–	0.06	0.08	–	–	–	2	0.04
Gyroidina orbiculare	–	0.34	–	–	0.16	0.36	0.37	–	9	0.17
Hanzawaia sp.	1.79	–	–	0.39	0.47	0.55	0.49	–	22	0.42
Haynesina germanica	–	1.02	3.42	0.39	0.32	0.36	0.85	0.21	22	0.42
Höglundina elegans	–	0.51	–	0.19	–	0.27	0.37	0.62	12	0.23
Involutina sp.	–	–	–	0.13	–	–	–	–	2	0.04
Lagena gracilis	–	0.09	–	0.19	0.08	0.18	–	–	6	0.11
Lagena nebulosa	–	–	–	–	–	–	0.12	–	1	0.02
Lagena semilineata	–	–	–	–	0.16	–	–	–	2	0.04
Lagena stelligera	0.23	–	–	0.06	0.24	–	–	–	4	0.08
Laryngosigma hyalascidia	0.08	–	–	–	–	–	–	–		0.00
Lenticulina gibba	–	0.09	–	–	0.08	–	0.12	–	2	0.04
Marginulina obesa	–	–	–	0.06	0.08	–	0.12	–	3	0.06
Melonis zaandami	0.93	0.68	–	0.90	2.05	1.18	1.34	1.04	69	1.32
Nodosaria calomorpha	–	0.09	–	–	–	–	–	–		0.00
Nonionella auricula	6.30	12.89	8.22	11.30	12.07	12.45	12.30	4.77	590	11.28
Nonionellina labradorica	0.62	0.09	–	0.19	0.24	0.27	0.24	0.83	15	0.29
Oolina apiculata	–	–	–	–	–	–	–	–		0.00
Oolina globosa	0.08	0.68	–	–	0.08	0.18	–	–	3	0.06
Oolina williamsoni	0.16	–	–	–	–	–	–	–		0.00
Parafissurina fusiliformis	0.39	0.51	–	0.26	0.16	0.18	–	–	8	0.15
Patellina corrugata	0.08	0.17	–	0.26	0.16	–	–	–	6	0.11
Procerolagena distoma	0.08	–	–	–	–	0.18	0.12	0.21	4	0.08
Procerolagena quadrilatera	0.54	0.26	–	0.39	0.16	–	0.12	–	9	0.17
Protelphidium orbiculare	1.32	0.34	–	0.83	0.71	0.82	0.37	–	34	0.65
Pullenia bulloides	0.86	1.71	–	1.09	0.95	1.27	0.61	1.04	53	1.01
Pullenia osloensis	0.23	–	0.68	–	–	–	–	–		0.00
Pullenia quinqueloba	–	0.17	–	0.45	0.16	–	0.37	0.83	16	0.31
Pyrgo murrhina	0.08	–	1.37	–	0.16	–	–	–	2	0.04
Quinqueloculina seminula	0.08	0.34	–	–	0.08	0.09	–	–	2	0.04
Robertinoides charlottensis	0.23	0.34	–	–	0.08	0.64	0.24	0.21	11	0.21
Robertinoides pumilum	0.08	–	–	–	–	–	–	–		0.00
Rutherfordoides cf. *mexicana*	3.66	0.51	–	2.25	0.71	0.64	2.07	2.70	81	1.55
Stainforthia concava	–	–	2.05	–	0.08	–	–	–	1	0.02
Triloculina frigida	–	0.26	–	–	–	0.09	–	–	1	0.02
Triloculina trihedra	0.47	–	–	0.13	–	0.18	–	–	4	0.08
Uvigerina peregrina	–	–	–	0.06	–	0.09	0.12	–	3	0.06

Box core 1 - continued:	Surface 1	Surface 2	Surface 3	1AA	1CC	1EE	1GG	1II	Total counts	Relative % in all subsamples
Uvigerina sp.	–	0.09	–	–	–	–	–	–		0.00
Valvulineria arctica	3.35	0.34	–	0.77	0.08	0.27	–	–	16	0.31
Calcareous total counts	**811**	**286**	**90**	**960**	**736**	**620**	**519**	**341**	**3176**	**73.00**
Agglutinated species										
Ammodiscus incertus	0.08	–	0.68	0.06	0.08	0.09	–	–	3	0.27
Arenoturrispirillina sp.	0.08	–	–	–	–	–	–	–		0.00
Argillotuba argillacea	–	–	–	–	–	–	–	–		0.00
Armorella sphaerica	0.16	0.34	–	0.19	–	0.09	0.85	0.21	12	1.09
Cribrostomoides subglobosus	–	–	–	–	–	–	0.37	–	3	0.27
Cribrostomoides wiesneri	0.08	0.17	–	0.19	0.16	0.18	–	–	7	0.64
Cyclammina pusilla	–	–	–	0.13	–	0.18	0.24	1.87	15	1.37
Dendrophyra arborescens	3.89	7.00	11.64	5.13	4.50	6.91	3.78	2.70	257	23.43
Deuterammina goughensis	0.23	–	–	–	–	0.18	–	0.21	3	0.27
Deuterammina grahami	1.09	0.60	–	0.51	0.87	1.00	0.61	0.83	39	3.56
Earlandammina inconspicua	3.81	3.59	–	3.66	3.15	3.45	1.46	1.66	155	14.13
Globotrochamminopsis bellingshauseni	–	0.77	–	–	0.39	0.82	0.97	0.83	26	2.37
Glomospira gordialis	0.23	0.51	–	0.13	0.24	0.55	0.37	0.62	17	1.55
Haplophragmoides canariensis	0.31	0.26	–	0.26	0.63	0.36	0.37	0.41	21	1.91
Hormosina globulifera	–	–	–	–	–	–	0.49	–	4	0.36
Hyperammina/Rhabdammina	1.25	0.60	–	–	0.16	–	–	–	2	0.18
Karreriella novangliae	0.16	–	–	0.13	–	–	0.12	–	3	0.27
Lagenammina tubulata	0.08	0.09	–	0.19	0.24	0.27	–	–	9	0.82
Marsipella cylindrica	1.25	1.71	–	1.41	0.79	0.91	1.10	3.94	70	6.38
Paratrochammina earlandi	0.86	1.02	2.74	0.96	0.39	0.91	0.61	1.45	42	3.83
Pelosina bicaudata	–	0.09	–	–	–	–	–	–		0.00
Pelosina cylindrica	0.08	0.09	–	–	0.16	–	–	–	2	0.18
Placopsinella aurantiaca	–	–	–	0.06	0.16	0.09	0.24	–	6	0.55
Psammosphaera fusca	0.16	–	–	–	–	–	–	–		0.00
Pseudotrochammina arenacea	–	0.17	–	–	0.24	–	–	–	3	0.27
Pseudotrochammina echolsi	–	0.17	–	–	–	–	–	0.41	2	0.18ß
Recurvoides contortus	–	–	–	–	–	–	0.12	0.41	3	0.27
Recurvoides scitulus	–	0.09	–	–	–	–	–	0.62	3	0.27
Recurvoides sp.	–	0.09	–	–	–	–	–	0.62	3	0.27
Reophax bilocularis	–	0.43	–	0.32	0.71	0.09	0.85	0.83	26	2.37
Reophax guttifer	–	0.17	–	–	–	0.09	–	–	1	0.09
Reophax scorpiurus	0.47	0.17	1.37	0.96	0.95	1.73	1.83	0.21	62	5.65
Repmanina charoides	0.31	0.26	–	0.26	0.47	0.36	0.24	–	16	1.46
Rhizammina algaeformis	1.25	0.51	–	0.19	0.63	0.55	0.61	0.41	24	2.19
Rhizammina indivisa	–	0.17	–	0.77	0.55	0.09	–	–	20	1.82
Saccammina sphaerica	1.48	0.94	–	–	0.95	–	1.10	3.11	36	3.28
Saccorhiza ramosa	0.16	0.17	–	0.51	0.55	0.18	–	2.07	27	2.46
Subreophax aduncus	0.23	0.85	–	0.83	1.42	0.82	0.73	1.04	51	4.65
Textularia torquata	–	0.34	–	0.19	0.24	0.27	0.24	0.41	13	1.19
Textularia wiesneri	0.31	0.26	2.74	0.26	0.16	0.18	0.12	0.83	13	1.19
Thurammina papillata	0.08	0.43	–	0.06	–	0.27	0.37	1.04	12	1.09
Thurammina papyracea	–	0.09	–	0.32	0.08	0.09	0.12	–	8	0.73
Tolypammina vagans	0.39	2.05	–	1.48	2.13	1.09	0.49	2.49	78	7.11
Agglutinated total counts	**237**	**283**	**28**	**299**	**266**	**240**	**151**	**141**	**1097**	
Foraminifera total counts	**1048**	**569**	**118**	**1259**	**1002**	**860**	**670**	**482**	**4273**	**100**

Box core 4	Surface 1	Surface 2	4AA	4BB	4DD	4EE	4FF	Total counts	Relative % in all subsamples
% counted in subsample	12.5	12.5	12.5	12.5	25	12.5	12.5		
Calcareous species									
Astacolus reniformis	–	0.14	0.23	–	0.14	–	0.06	5	0.07
Astrononion gallowayi	–	–	–	–	–	0.07	–	1	0.01
Bolivina subspinescens	–	–	–	–	–	0.29	–	4	0.06
Buccella frigida	–	–	–	–	–	0.14	–	2	0.03
Cibicides rugosus	0.05	–	–	–	–	–	–		0.00
Cibicides sp.	0.05	0.07	0.35	–	0.28	0.14	0.12	11	0.16
Cibicidoides lobatulus	0.90	0.85	0.12	1.42	1.33	1.14	0.43	64	0.94
Cibicidoides wuellerstorfi	0.37	0.50	0.70	0.20	0.21	0.50	0.12	21	0.31
Cribroelphidium excavatum	0.05	–	0.35	0.14	0.21	0.21	–	11	0.16
Cribroelphidium subarcticum	–	–	0.12	–	–	0.07	–	2	0.03
Cribroelphidium sp.	–	–	0.23	0.07	–	–	–	3	0.04
Dentalina frobisherensis	–	–	–	0.07	–	–	–	1	0.01
Epistominella exigua	–	–	–	0.07	–	–	–	1	0.01
Fissurina bradyii	0.05	–	–	–	–	–	–		0.00
Fissurina fimbriata	0.58	0.78	1.39	0.68	1.40	0.71	1.48	76	1.12

Box core 4 - continued:	Surface 1	Surface 2	4AA	4BB	4DD	4EE	4FF	Total counts	Relative % in all subsamples
Fissurina kerguelensis	–	–	–	–	–	–	0.06	1	0.01
Fissurina marginata	0.05	0.14	0.46	0.07	–	0.14	0.06	8	0.12
Fissurina semimarginata	–	–	–	–	–	–	0.06	1	0.01
Fissurina seminiformis	–	–	–	–	–	–	0.06	1	0.01
Fissurina sp.	0.47	0.14	–	–	–	–	0.06	1	0.01
Gyroidina orbiculare	–	–	–	0.07	–	0.07	–	2	0.03
Haynesina germanica	–	–	0.12	0.27	0.14	0.79	–	18	0.26
Höglundina elegans	0.26	0.14	0.81	0.27	0.21	0.14	0.74	28	0.41
Lagena flatulenta	–	0.14	0.35	0.07	0.14	–	0.06	7	0.10
Lagena hispida	–	0.07	–	–	–	–	–		0.00
Lagena hispidula	–	–	–	–	–	0.07	–	1	0.01
Lagena meridionalis	–	–	–	–	–	0.07	–	1	0.01
Lagena nebulosa	–	–	0.46	–	–	–	–	4	0.06
Lagena semilineata	0.11	0.14	–	0.07	0.14	0.14	0.12	7	0.10
Laryngosigma hyalascidia	–	–	–	0.07	–	–	–	1	0.01
Lenticulina gibba	0.42	0.07	–	–	0.49	0.14	–	9	0.13
Marginulina obesa	0.05	–	–	–	–	–	–		0.00
Marginulinopsis linearis	0.05	–	–	–	–	–	–		0.00
Melonis zaandami	–	–	–	0.07	–	–	–	1	0.01
Nodosaria calomorpha	–	–	–	–	–	0.07	–	1	0.01
Nonionella auricula	–	–	–	2.03	0.49	1.00	–	51	0.75
Nonionellina labradorica	0.26	0.14	–	–	0.14	0.14	0.12	6	0.09
Oolina apiculata	–	–	–	–	0.07	–	–	1	0.01
Oolina globosa	0.11	–	–	–	–	–	0.12	2	0.03
Oridorsalis umbonatus	–	–	0.23	–	–	–	–	2	0.03
Oridorsalis sp.	–	–	–	–	–	0.07	–	1	0.01
Parafissurina fusiliformis	0.05	–	–	–	–	–	–		0.00
Parafissurina lateralis	0.05	–	–	–	–	–	–		0.00
Parafissurina sp.	–	0.07	0.23	–	–	–	–	2	0.03
Pullenia bulloides	0.16	0.28	0.12	–	0.28	0.21	–	8	0.12
Pullenia osloensis	0.47	0.64	0.70	0.54	0.56	0.36	0.56	36	0.53
Pullenia quinqueloba	–	0.21	0.35	–	–	–	–	3	0.04
Pyrgo murrhina	–	–	0.35	0.20	0.14	–	0.25	12	0.18
Stainforthia concava	2.90	8.17	11.36	21.61	24.01	16.20	4.44	1061	15.61
Calcareous total counts	**142**	**179**	**165**	**414**	**435**	**321**	**145**	**1480**	**22**
Agglutinated species									
Ammobaculites agglutinans	4.06	2.49	–	1.42	2.65	1.78	4.69	160	2.35
Ammodiscus incertus	0.11	0.07	–	–	–	–	0.06	1	0.01
Ammoscalaria tenuimargo	0.74	0.36	–	1.35	0.49	0.71	–	37	0.54
Arenoturrispirillina sp.	–	–	–	–	–	–	0.06	1	0.01
Argillotuba argillacea	0.32	0.21	0.12	0.61	0.42	0.43	0.12	24	0.35
Armorella sphaerica	–	–	–	–	0.14	0.14	–	4	0.06
Astrorhiza crassatina	16.62	24.16	17.38	14.52	3.14	23.84	17.96	1035	15.23
Bathysiphon rufus	0.11	–	–	–	–	–	–		0.00
Cribrostomoides wiesneri	–	0.50	0.23	–	–	0.14	0.31	9	0.13
Cyclammina pusilla	0.32	0.28	0.12	0.14	0.49	0.57	0.49	26	0.38
Cystammina pauciloculata	0.05	0.07	0.12	0.07	0.14	0.14	0.12	8	0.12
Dendrophyra arborescens	0.79	2.70	1.16	3.85	3.00	1.57	1.17	151	2.22
Deuterammina goughensis	0.95	1.21	–	1.22	1.47	0.43	1.91	76	1.12
Globotrochamminopsis bellingshauseni	5.65	6.97	4.17	4.73	8.79	5.35	9.63	463	6.81
Glomospira gordialis	0.05	–	–	0.20	0.07	–	–	4	0.06
Haplophragmoides canariensis	0.53	1.35	0.70	0.54	1.54	0.50	1.48	67	0.99
Hormosina globulifera	0.26	0.14	–	0.34	0.14	0.64	0.06	17	0.25
Hyperammina elongata	0.63	0.57	0.81	–	0.56	0.29	0.25	23	0.34
Hyperammina/Rhabdammina fragments	30.40	24.88	34.65	19.92	29.52	21.20	31.17	1819	26.76
Jaculella acuta	–	0.36	–	–	–	–	–		0.00
Karreriella novangliae	0.11	0.21	0.35	–	–	–	0.12	5	0.07
Lagenammina tubulata	–	–	–	0.07	–	–	–	1	0.01
Lituituba lituiformis	–	–	0.12	–	–	–	–	1	0.01
Marsipella cylindrica	1.27	0.50	–	0.74	–	0.29	0.49	23	0.34
Marsipella elongata	–	–	0.46	0.34	–	–	0.25	13	0.19
Placopsinella aurantiaca	–	–	–	0.07	–	–	–	1	0.01
Pelosina bicaudata	–	–	–	0.07	0.21	–	–	4	0.06
Pelosina cylindrica	0.32	–	0.12	0.14	–	0.07	0.19	7	0.10
Psammosphaera fusca	–	0.50	–	0.54	0.28	0.29	0.31	21	0.31
Recurvoides contortus	0.84	1.07	1.27	0.74	0.07	1.86	0.74	61	0.90
Recurvoides scitulus	1.42	1.49	–	0.88	1.19	0.57	0.99	54	0.79
Recurvoides sp.	0.74	1.28	1.27	0.34	0.84	–	0.49	36	0.53
Reophax bacillaris	–	–	–	–	0.07	–	0.12	3	0.04
Reophax bilocularis	–	0.07	0.46	–	–	–	–	4	0.06
Reophax ovicula	–	–	0.12	–	–	–	–	1	0.01

Box core 4 - continued:	Surface 1	Surface 2	4AA	4BB	4DD	4EE	4FF	Total counts	Relative % in all subsamples
Reophax scorpiurus	0.90	1.07	1.16	2.84	1.67	1.50	2.10	131	1.93
Repmanina charoides	–	–	–	0.14	–	–	–	2	0.03
Rhabdammina abyssorum	–	0.21	0.70	0.34	0.14	0.29	0.31	22	0.32
Rhabdammina agglutissima	1.58	1.49	1.27	0.54	0.70	0.14	0.62	41	0.60
Rhabdammina linearis	1.48	0.85	4.29	0.88	0.35	1.28	1.79	102	1.50
Rhizammina algaeformis	12.08	3.70	1.39	2.16	1.81	2.93	0.99	127	1.87
Rhizammina indivisa	0.90	0.50	0.70	1.62	1.12	1.28	1.23	84	1.24
Portatrochammina antarctica	–	–	–	–	–	–	0.06	1	0.01
Pseudotrochammina arenacea	0.16	0.36	–	0.41	0.49	0.57	0.31	26	0.38
Pseudotrochammina echolsi	–	–	–	0.14	–	–	0.12	4	0.06
Saccamina sphaerica	–	0.07	–	0.54	0.70	0.79	1.23	49	0.72
Saccorhiza ramosa	7.12	2.06	6.26	1.89	1.74	1.21	6.05	222	3.27
Subreophax aduncus	1.06	2.20	0.23	1.96	0.35	1.00	1.42	73	1.07
Textularia torquata	0.63	1.07	0.70	2.30	3.28	3.21	0.68	143	2.10
Textularia wiesneri	0.26	2.13	0.58	2.84	1.95	2.07	0.93	119	1.75
Thurammina papillata	–	0.14	–	0.41	–	–	–	6	0.09
Trochamminopsis conicus	0.05	–	0.12	0.27	0.14	–	–	7	0.10
Agglutinated total counts	**1753**	**1228**	**699**	**1067**	**998**	**1080**	**1475**	**5319**	**78.00**
Foraminifera total counts	**1895**	**1407**	**864**	**1481**	**1433**	**1401**	**1620**	**6799**	**100.00**

Box core 6	Surface	6AA	6BB	6CC	6DD	6EE	6GG	6HH	6II	Total counts	Relative % in all subsamples
% counted in subsample	95	95	95	25	95	25	95	95	95		
Agglutinated species											
Adercotryma glomerata	11.11	15.84	–	23.98	35.30	42.26	32.35	22.41	42.29	2436	31.80
Ammodiscus incertus	–	–	–	–	0.06	–	0.08	–	0.09	3	0.04
Argillotuba argillacea	22.22	4.75	–	5.81	5.57	13.06	4.02	6.33	5.81	472	6.16
Aschemonella ramulifera	–	0.90	–	–	0.50	1.08	1.21	0.44	2.00	64	0.84
Aschemonella scabra	–	–	–	0.18	0.61	0.40	0.53	0.35	–	27	0.35
Astrorhiza crassatina	–	22.40	–	14.26	3.53	7.40	6.29	8.17	5.72	614	8.02
Cribrostomoides wiesneri	–	–	–	0.09	0.17	0.13	1.29	0.62	0.36	33	0.43
Dendrophyra arborescens	–	–	–	–	–	–	0.08	–	–	1	0.01
Deuterammina goughensis	–	–	–	–	–	0.27	0.08	–	–	3	0.04
Globotrochamminopsis bellingshauseni	7.41	–	–	–	–	0.13	–	–	–	1	0.01
Hyperammina elongata	–	–	–	–	–	–	0.30	0.09	0.09	6	0.08
Hyperammina/*Rhabdammina* fragments	–	–	–	0.73	0.77	0.13	0.83	1.14	0.54	53	0.69
Pelosina bicaudata	–	–	–	–	–	0.40	–	0.09	–	4	0.05
Psammosphaera fusca	–	0.23	–	6.54	0.50	2.56	–	1.85	0.45	127	1.66
Pseudonodosinella nodulosa	–	–	–	–	0.11	–	0.30	0.18	–	8	0.10
Recurvoides contortus	25.93	26.92	–	8.63	9.76	3.50	8.03	13.53	10.16	789	10.30
Recurvoides sp.	7.41	8.82	–	4.18	7.83	1.88	5.68	9.84	6.72	502	6.55
Reophax bilocularis	–	–	–	2.18	–	2.02	0.30	0.53	0.27	52	0.68
Reophax distans	–	–	–	0.82	–	–	–	–	–	9	0.12
Reophax fusiformis	–	–	–	–	–	–	–	0.18	–	2	0.03
Reophax guttifer	–	2.04	–	12.62	16.38	9.29	15.00	14.24	10.44	989	12.91
Reophax ovicula	–	0.23	–	0.36	1.16	0.67	0.68	1.23	1.18	67	0.87
Reophax scorpiurus	3.70	0.23	–	1.54	2.48	3.36	2.05	0.88	1.18	138	1.80
Rhizammina algaeformis	–	–	100.00	1.63	–	0.81	1.44	0.88	–	54	0.70
Rhizammina indivisa	7.41	0.45	–	0.09	–	0.81	0.15	0.09	0.09	13	0.17
Rhabdammina agglutissima	–	14.93	–	9.54	8.27	4.17	8.33	9.23	5.63	629	8.21
Saccammina sphaerica	–	–	–	0.18	–	–	0.08	–	0.18	5	0.07
Subreophax aduncus	–	0.45	–	0.27	0.39	1.21	–	0.18	0.27	26	0.34
Textularia wiesneri	14.81	1.81	–	6.36	6.56	4.44	10.76	7.56	6.26	527	6.88
Thurammina papillata	–	–	–	–	0.06	–	0.15	–	0.27	6	0.08
Total counts	**27**	**442**	**1**	**1101**	**1813**	**743**	**1320**	**1138**	**1102**	**7660**	**100**

Box core 9	9BB	9CC	9DD	9EE	9FF	9HH	9II	Total counts	Relative % in all subsamples
% counted in subsample	95	95	95	95	95	62.5	95		
Agglutinated species									
Adercotryma glomerata	5.37	65.07	50.80	67.01	9.26	11.47	0.00	2023	48.10
Ammodiscus incertus	0.00	0.00	0.00	0.07	0.00	0.00	0.00	1	0.02
Argillotuba argillacea	30.73	3.46	23.94	8.19	12.04	48.62	61.09	710	16.88
Aschemonella ramulifera	0.00	0.37	0.00	0.00	0.00	0.00	0.00	4	0.10
Aschemonella scabra	0.00	0.00	2.93	0.15	0.00	0.00	0.00	24	0.57
Cribrostomoides wiesneri	0.00	0.19	0.13	0.30	0.00	0.00	0.00	7	0.17
Globotrochamminopsis bellingshauseni	0.00	0.00	0.13	0.00	0.00	0.00	0.00	1	0.02
Hyperammina/*Rhabdammina* fragments	0.00	1.87	0.93	3.43	2.78	2.75	0.00	82	1.95

Box core 9 – continued:	9BB	9CC	9DD	9EE	9FF	9HH	9II	Total counts	Relative % in all subsamples
Lagenammina laguncula	0.00	0.00	0.00	0.00	0.00	0.00	10.33	34	0.81
Paratrochammina challengeri	0.00	0.00	0.00	0.00	0.00	0.00	1.82	6	0.14
Pelosina bicaudata	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2	0.05
Psammosphaera fusca	0.00	0.00	1.06	0.00	0.00	0.00	0.00	8	0.19
Recurvoides contortus	15.12	6.27	1.20	4.77	15.74	21.56	3.34	246	5.85
Recurvoides sp.	13.17	6.09	0.27	3.57	14.81	6.88	0.00	173	4.11
Reophax bilocularis	0.00	0.09	1.46	0.60	0.00	0.00	0.00	20	0.48
Reophax brevis	0.00	0.47	0.00	0.00	0.00	0.00	0.00	5	0.12
Reophax guttifer	1.95	0.75	0.80	4.32	7.41	0.00	0.91	87	2.07
Reophax ovicula	0.49	0.47	0.00	0.45	0.00	0.00	0.00	12	0.29
Reophax pilulifer	1.95	0.00	0.00	0.00	0.00	0.00	0.00	4	0.10
Reophax scorpiurus	1.46	1.03	0.66	0.07	5.56	0.00	2.13	33	0.78
Rhabdammina agglutissima	12.20	5.71	6.12	7.07	27.78	0.46	3.34	269	6.40
Rhizammina algaeformis	0.00	0.00	1.46	0.00	0.00	0.00	0.30	12	0.29
Rhizammina indivisa	0.49	0.00	0.53	0.00	0.00	0.00	0.30	6	0.14
Saccammina sphaerica	0.00	0.00	0.80	0.00	0.00	0.92	0.91	11	0.26
Subreophax aduncus	0.00	0.00	1.06	0.00	0.00	0.00	0.00	8	0.19
Textularia wiesneri	11.71	7.77	4.39	0.00	4.63	6.42	15.50	210	4.99
Thurammina papillata	5.37	0.00	0.93	0.00	0.00	0.00	0.00	18	0.43ß
Thurammina papyracea	0.00	0.37	0.40	0.00	0.00	0.00	0.00	7	0.17
Total counts	**205**	**1068**	**752**	**1343**	**108**	**329**	**218**	**4023**	**100**

Box core 13	13AA	13CC	13DD	13EE	13FF	13GG	13II	Total counts	Relative % in all subsamples
% counted in subsample	25	25	12.5	25	25	25	25		
Agglutinated species									
Argillotuba argillacea	16.53	7.53	7.22	2.63	21.75	15.30	8.64	522	11.13
Astrorhiza arenaria	0.00	0.13	0.21	0.00	0.14	0.00	0.00	3	0.06
Bathysiphon rufus	0.00	0.13	0.00	0.00	0.00	0.00	0.00	1	0.02
Cribrostomoides wiesneri	2.34	0.52	1.65	5.61	1.52	7.11	8.35	177	3.78
Crithionina hispida	0.00	0.00	0.00	0.00	0.00	0.00	0.29	2	0.04
Haplophragmoides canariensis	0.00	0.26	0.00	0.00	0.00	0.00	0.00	2	0.04
Hippocrepinella hirudinea	0.14	0.13	0.00	0.00	0.42	0.22	0.00	6	0.13
Hyperammina cylindrica	0.41	2.21	3.09	0.36	2.08	2.37	1.32	73	1.56
Hyperammina elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.73	5	0.11
Hyperammina/*Rhabdammina* fragments	16.25	27.27	26.39	21.00	18.98	20.04	17.42	981	20.93
Lagenammina laguncula	24.38	19.22	7.42	28.52	9.83	17.67	26.35	933	19.90
Lagenammina tubulata	0.00	0.39	0.00	0.00	0.00	0.00	0.73	8	0.17
Paratrochammina challengeri	0.55	0.26	0.62	2.03	0.69	1.51	1.02	45	0.96
Placopsinella aurantiaca	0.00	0.00	0.21	0.00	0.00	0.00	0.00	1	0.02
Recurvoides contortus	3.17	4.03	12.58	10.74	5.96	5.39	6.59	318	6.78
Reophax bilocularis	8.95	1.69	2.06	0.60	3.88	4.53	0.88	148	3.16
Reophax distans	0.00	0.00	0.41	0.00	0.00	0.00	0.15	3	0.06
Reopha fusiformis	0.00	0.00	0.21	0.00	0.00	0.00	0.00	1	0.02
Reophax guttifer	13.64	6.36	9.07	7.28	7.06	4.31	6.88	371	7.91
Reophax ovicula	0.00	0.00	0.21	0.00	0.14	0.00	0.00	2	0.04
Reophax scorpiurus	2.07	1.95	1.65	0.00	0.55	0.22	0.88	49	1.05
Reophax spp.	0.14	0.26	1.44	2.74	0.42	1.08	1.76	53	1.13
Rhabdammina abyssorum	0.00	2.73	2.68	1.07	4.85	3.23	1.90	106	2.26
Rhabdammina agglutissima	0.00	0.13	0.00	0.00	0.00	0.00	0.00	1	0.02
Rhabdammina discreta	6.75	18.83	20.41	12.17	17.59	15.30	11.86	674	14.38
Rhabdammina irregularis	0.00	0.00	0.00	0.00	0.14	0.00	0.15	2	0.04
Rhabdammina linearis	0.41	0.00	0.21	0.00	0.28	0.00	0.00	6	0.13
Rhizammina algaeformis	2.89	3.51	0.82	1.91	2.35	0.22	0.73	91	1.94
Rhizammina indivisa	0.14	0.39	0.00	0.00	0.14	0.00	0.44	8	0.17
Saccammina sphaerica	0.00	0.00	0.21	0.00	0.42	0.65	0.44	10	0.21
Saccorhiza ramosa	0.00	0.00	0.00	0.00	0.14	0.22	0.00	2	0.04
Textularia wiesneri	1.24	1.95	1.24	3.22	0.69	0.43	2.49	81	1.73
Thurammina papyracea	0.00	0.13	0.00	0.12	0.00	0.22	0.00	3	0.06
Total counts	**726**	**770**	**485**	**838**	**722**	**464**	**683**	**4688**	**100**

Box core 14	Surface	14AA	14BB	14CC	14DD	14EE	14GG	14II	Total counts	Relative % in all subsamples
% counted in subsample		50	50	50	25	37.5	50	37.5		
Agglutinated species										
Adercotryma glomerata	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.18	2	0.05
Aggerostramen rusticum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	1	0.03
Argillotuba argillacea	40.40	21.33	20.10	22.50	8.39	10.82	18.18	8.15	588	15.45

Box core 14 – continued:	Surface	14AA	14BB	14CC	14DD	14EE	14GG	14II	Total counts	Relative % in all subsamples
Astrorhiza crassatina	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.18	2	0.05
Bathysiphon rufus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	5	0.13
Cribrostomoides subglobosus	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	1	0.03
Cribrostomoides wiesneri	0.51	0.00	0.17	0.00	0.00	0.17	1.60	0.91	16	0.42
Dendrophyra arborescens	0.51	0.69	0.00	0.00	0.00	0.35	0.00	0.00	5	0.13
Hippocrepinella hirudinea	0.00	0.00	0.17	0.18	0.18	0.17	1.78	1.27	21	0.55
Hyperammina cylindrica	0.51	0.00	0.00	4.36	0.18	1.40	3.39	1.09	58	1.52
Hyperammina elongata	24.75	1.15	5.42	2.90	0.00	0.00	0.18	0.18	54	1.42
Hyperammina/Rhabdammina fragments	0.00	21.56	25.17	18.69	20.71	28.27	23.71	24.28	886	23.29
Lagenammina laguncula	3.54	16.74	8.92	2.36	21.43	11.69	4.46	8.15	394	10.35
Lagenammina tubulata	0.00	0.23	0.00	0.18	0.71	0.17	0.00	0.00	7	0.18
Paratrochammina challengeri	0.51	2.06	1.40	0.00	0.89	1.22	1.60	0.91	43	1.13
Placopsinella aurantiaca	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	1	0.03
Pseudonodosinella nodulosa	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	1	0.03
Recurvoides contortus	1.52	2.75	2.80	4.17	4.29	6.46	5.88	4.35	169	4.44
Reophax bilocularis	0.00	0.00	0.00	0.18	6.25	0.70	0.00	2.17	52	1.37
Reophax distans	0.00	0.23	0.00	0.00	0.00	0.35	0.00	0.00	3	0.08
Reophax fusiformis	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	2	0.05
Reophax guttifer	2.02	3.44	3.32	0.18	9.82	5.06	4.46	4.35	168	4.42
Reophax ovicula	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	3	0.08
Reophax scorpiurus	1.52	2.75	1.92	2.18	4.29	8.55	3.74	9.96	184	4.84
Reophax spp.	0.51	0.00	0.00	0.00	1.07	1.05	0.00	0.18	13	0.34
Rhabdammina abyssorum	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.54	7	0.18
Rhabdammina agglutissima	4.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
Rhabdammina discreta	0.00	6.42	17.66	23.23	10.00	13.26	18.54	15.94	581	15.27
Rhabdammina linearis	0.00	3.44	2.45	1.63	1.61	0.70	2.14	3.99	85	2.23
Rhizammina algaeformis	9.60	14.45	9.62	12.16	7.32	5.41	4.46	9.24	333	8.75
Rhizammina indivisa	0.00	1.15	0.17	2.18	0.00	1.22	1.43	1.63	42	1.10
Rhizammina spp.	8.59	0.00	0.00	2.00	0.71	2.09	1.96	1.09	44	1.16
Saccammina sphaerica	0.00	0.00	0.00	0.00	0.89	0.00	2.32	0.00	18	0.47
Saccorhiza ramosa	0.51	0.00	0.00	0.00	0.00	0.52	0.00	0.00	3	0.08
Textularia wiesneri	0.00	0.46	0.00	0.00	0.36	0.35	0.00	0.00	6	0.16
Thurammina papillata	0.51	1.15	0.17	0.00	0.00	0.00	0.00	0.18	7	0.18
Total counts	**198**	**436**	**572**	**551**	**560**	**573**	**561**	**552**	**3805**	**100**

Box core 15	15AA	15CC	15DD	15EE	15FF	15GG	15II	Total counts	Relative % in all subsamples
% counted in subsample	100.00	50	25	25	25	25	25		
Agglutinated species									
Argillotuba argillacea	17.58	9.18	4.08	3.41	8.68	10.29	9.25	368	9.62
Aschemonella scabra	0.00	0.00	0.34	0.00	0.00	0.00	0.00	2	0.05
Astrorhiza crassatina	0.00	0.20	0.00	0.00	0.00	0.21	0.66	5	0.13
Bathysiphon rufus	0.00	0.20	0.00	0.00	0.00	0.00	0.00	1	0.03
Cribrostomoides subglobosus	1.16	0.98	0.85	0.00	0.91	0.00	0.22	25	0.65
Cribrostomoides wiesneri	0.12	0.00	0.00	0.00	0.23	0.00	0.44	4	0.10
Crithionina hispida	0.00	0.00	0.00	0.00	0.00	0.21	0.00	1	0.03
Hyperammina cylindrica	0.23	0.78	9.35	4.22	3.42	3.57	0.88	118	3.08
Hyperammina elongata	0.00	0.59	0.34	0.40	0.68	1.05	1.32	21	0.55
Hyperammina/Rhabdammina fragments	6.29	3.32	0.51	0.00	0.00	1.26	4.85	102	2.67
Labrospira crassimargo	0.00	0.00	0.51	0.00	0.00	0.00	0.00	3	0.08
Lagenammina laguncula	1.40	1.56	1.53	4.22	6.39	2.31	7.05	121	3.16
Lagenammina tubulata	0.12	0.00	0.00	0.00	0.00	0.00	0.44	3	0.08
Paratrochammina challengeri	0.00	0.20	0.00	0.00	0.91	0.00	1.10	10	0.26
Placopsinella aurantiaca	0.00	0.00	0.00	0.00	0.00	0.00	1.76	8	0.21
Psammosphaera fusca	0.00	1.37	4.59	2.61	1.83	1.05	0.88	64	1.67
Recurvoides contortus	45.29	54.10	39.63	42.97	39.27	40.34	27.75	1603	41.91
Reophax bilocularis	1.40	0.00	0.00	0.00	0.46	0.00	1.10	19	0.50
Reophax fusiformis	1.16	0.98	1.87	1.00	2.74	1.26	0.66	52	1.36
Reophax guttifer	1.05	0.39	0.00	0.00	1.60	0.00	9.03	59	1.54
Reophax scorpiurus	12.11	8.40	12.24	10.04	17.81	10.71	6.39	427	11.16
Rhabdammina abyssorum	0.00	0.00	0.00	0.00	0.00	0.21	0.00	1	0.03
Rhabdammina agglutissima	10.94	6.25	11.90	16.47	7.53	11.34	14.10	429	11.22
Rhabdammina discreta	0.00	1.76	11.73	10.24	6.16	11.55	10.79	260	6.80
Rhabdammina linearis	0.00	8.98	0.00	0.00	0.00	3.57	0.66	66	1.73
Rhizammina algaeformis	0.00	0.20	0.00	0.00	0.00	0.00	0.00	1	0.03
Rhizammina indivisa	0.00	0.00	0.51	1.00	1.14	0.00	0.00	13	0.34
Rhizammina spp.	1.05	0.59	0.00	3.41	0.00	1.05	0.00	34	0.89
Saccammina sphaerica	0.00	0.00	0.00	0.00	0.00	0.00	0.22	1	0.03
Textularia wiesneri	0.00	0.00	0.00	0.00	0.23	0.00	0.22	2	0.05
Thurammina papyracea	0.12	0.00	0.00	0.00	0.00	0.00	0.22	2	0.05
Total counts	**859**	**512**	**588**	**498**	**438**	**476**	**454**	**3825**	**100**

APPENDIX 2: Foraminiferal species list (alphabetical order)

Adercotryma glomerata (Brady)
Aggerostramen rusticum (Heron-Allen and Earland)
Ammobaculites agglutinans (d'Orbigny)
Ammodiscus incertus (d'Orbigny)
Ammoscalaria tenuimargo (Brady)
Arenoturrispirillina sp.
Argillotuba argillacea (Earland)
Armorella sphaerica Heron-Allen and Earland
Aschemonella ramulifera Brady
Aschemonella scabra Brady
Astacolus reniformis (d'Orbigny)
Astrononion gallowayi Loeblich and Tappan
Astrorhiza arenaria Carpenter
Astrorhiza crassatina Brady
Bathysiphon hirudinea (Heron-Allen and Earland)
Bathysiphon rufus De Folin
Bolivina subspinescens Cushman
Buccella floriformis Voloshinova
Buccella frigida (Cushman)
Cassidulina laevigata d'Orbigny
Cassidulina neoteretis Seidenkrantz
Cassidulina reniforme Nørvang
Cibicides rugosus Phleger and Parker
Cibicides sp.
Cibicidoides lobatulus (Walker and Jacob)
Cibicidoides wuellerstorfi (Schwager)
Cribroelphidium bartletti (Cushman)
Cribroelphidium clavatum (Cushman)
Cribroelphidium excavatum (Terquem)
Cribroelphidium incertum Williamson
Cribroelphidium subarcticum (Cushman)
Cribrostomoides subglobosus (Sars)
Cribrostomoides wiesneri (Parr)
Crithionina hispida Flint
Cyclammina pusilla Brady
Cystammina pauciloculata (Brady)
Dendrophyra arborescens (Norman)
Dentalina frobisherensis Loeblich and Tappan
Deuterammina goughensis Brönnimann and Whittaker
Deuterammina grahami Brönnimann and Whittaker
Earlandammina inconspicua (Earland)
Epistominella exigua (Brady)
Epistominella pacifica (Cushman)
Epistominella takayanagii Iwasa
Eponides frigidus (Cushman)
Favulina hexagona (Williamson)
Favulina melo (d'Orbigny)
Fissurina bradyii Silvestri
Fissurina fimbriata (Brady)
Fissurina kerguelensis Parr
Fissurina marginata (Montagu)
Fissurina orbignyana Seguenza
Fissurina semimarginata (Reuss)
Fissurina seminiformis (Schwager)
Globigerina bulloides D'Orbigny
Globotrochamminopsis bellingshauseni Brönnimann and Whittaker
Glomospira gordialis (Jones and Parker)
Glomospirella sp.
Gyroidina orbiculare d'Orbigny
Hanzawaia hamadaensis Asano
Haplophragmoides canariensis (d'Orbigny)
Haynesina germanica (Ehrenberg)
Hippocrepinella hirudinea Heron-Allen and Earland
Höglundina elegans (d'Orbigny)
Hormosina globulifera Brady
Hyperammina cylindrica Parr
Hyperammina elongata Brady
Involutina sp.
Jaculella acuta Brady
Karreriella novangliae (Cushman)
Labrospira crassimargo (Norman)
Lagena flatulenta Loeblich and Tappan
Lagena gracilis Wiesner
Lagena hispida Reuss
Lagena hispidula Cushman
Lagena meridionalis Wiesner
Lagena nebulosa Cushman
Lagena quadrilatera Earland
Lagena semilineata Wright
Lagena stelligera Brady
Lagenammina laguncula Rhumbler
Lagenammina tubulata (Rhumbler)
Laryngosigma hyalascidia Loeblich and Tappan
Lenticulina gibba (d'Orbigny)
Lituituba lituiformis (Brady)
Marginulina obesa (Cushman)
Marginulinopsis linearis (Montagu)
Marsipella cylindrica Brady
Marsipella elongata Norman
Melonis zaandami (Van Voorthuysen)
Neogloboquadrina pachyderma (Ehrenberg)
Nodosaria calomorpha Reuss
Nonionella auricula Heron-Allen and Earland
Nonionellina labradorica (Dawson)
Oolina apiculata Reuss
Oolina globosa (Montagu)
Oolina williamsoni (Alcock)
Oridorsalis umbonatus (Reuss)
Oridorsalis sp.
Parafissurina fusiliformis Loeblich and Tappan
Parafissurina lateralis (Cushman) f. simplex (Buchner)
Parafissurina sp.
Paratrochammina challengeri Brönnimann and Whittaker
Paratrochammina earlandi Brönnimann and Whittaker
Patellina corrugata Williamson
Pelosina bicaudata (Parr)
Pelosina cylindrica Brady
Placopsinella aurantiaca Earland
Portatrochammina antarctica antarctica (Parr)
Procerolagena distoma (Parker and Jones)
Procerolagena gracilis (Williamson)
Procerolagena quadrilatera (Earland)
Protelphidium orbiculare (Brady)
Psammosphaera fusca Schulze
Pseudonodosinella nodulosa (Brady)
Pseudotrochammina arenacea (Heron-Allen and Earland)
Pseudotrochammina echolsi Brönnimann and Whittaker
Pullenia bulloides (d'Orbigny)
Pullenia osloensis Feyling-Hanssen
Pullenia quinqueloba (Reuss)
Pulvinulina frigida Cushman
Pyrgo murrhina (Schwager)
Quinqueloculina seminula (Linné)
Recurvoides contortus Earland
Recurvoides scitulus (Brady)
Recurvoides sp. 1
Reophax bacillaris Brady
Reophax bilocularis Flint
Reophax brevis Parr
Reophax distans Brady
Reophax fusiformis (Williamson)
Reophax guttifer Brady
Reophax ovicula (Brady)
Reophax pilulifer Brady
Reophax scorpiurus Montfort
Repmanina charoides (Jones and Parker)
Rhabdammina abyssorum M. Sars in Carpenter
Rhabdammina agglutissima Høfker
Rhabdammina discreta Brady
Rhabdammina irregularis Carpenter
Rhabdammina linearis Brady
Rhizammina algaeformis Brady
Rhizammina indivisa Brady
Robertinoides charlottensis (Cushman)
Robertinoides pumilum Höglund
Rutherfordoides mexicana (Cushman)

APPENDIX 2: Foraminiferal species list (alphabetical order) – continued:

Saccammina sphaerica Brady
Saccorhiza ramosa (Brady)
Stainforthia concava (Höglund)
Subreophax aduncus (Brady)
Textularia torquata Parker
Textularia wiesneri Earland
Thurammina papillata Brady
Thurammina papyracea Cushman
Tolypammina vagans (Brady)
Triloculina frigida Lagoe
Triloculina trihedra Loeblich and Tappan
Trochammina lituiformis Brady
Trochamminopsis conicus (Earland)
Uvigerina peregrina Cushman
Uvigerina sp.
Valvulineria arctica Green
Vermiculum marginatum Montagu